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THE

WORKS

OF THE

HONOURABLE

Robert Boyle, Esq;

EPITOMIZ'D.

VOL. III.

BY

RICHARD BOULTON,

of Brazen-Nofe College in Oxford.

Illustrated with COPPER PLATES.

LONDON:

Printed for J. Phillips, at the King'-s Arms, and J. Taylor at the Ship in St. Paul's Church Tard, M.D.C.

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LONDON

Strong for F. Phillips, at the W. S. Annie, and S. Tophe at the Olivin St. Pan's Cherch To d. M DCC.

Most Hastrious Prince WILLIAM

Duke of Bedford, Marquis of Taviflock, Barl of Bedford, Baron Ruffel, and Baron Russel of Thornhaugh, Baron Howland of Streatham : Lord Lieutenant of the Counties of Bedford and Cambridge, and during the Minority of Wrichelly (commonly called Marquis of Tavis stock) his Grandson and Heir apparent, Lord Lieutenant of Middlelex; as also Custos Rotulorum for the faid County and the Liberties of Westminfter; One of the Lords of his Man jesty's most Honourable Privy Conneil and Knight of the most Noble Order of the Garter.

May it please your Grace,

THE Great and No-U ble Character which you have already obtain-

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The Dedication.

ed in the World, flath justly obliged them both to applaud and admire You, and no Wonder then, that it should raise in me an Ambition to lay this at Your Feet; where whilst I lye fecure from the Cenfure of the World under your Grace's Patronage, I have this great Advantage, that in whatever I can fay, in relation to your Illustrious Character, I cannot be Guilty of Flattery; fince the World universally agrees, that Your Noble Qualifications are not unworthy

The Dedication

fo Noble a Prince, Your Sagacity and Judgment nor being less conspicuous in State Affairs, than your Virtue and Piety in Divine things the Former having rendred You both acceptable and ferviceable in Council, las the Latter have made You an Eminent and Illustrious Example of Christianity; fo that You become serviceable to your Country upon a double score; Your Virtues incite your Admirers to purfue and emulate Good Actions, and your Wildom and

and Prudence contribute to the well Governing of a People, who are the more disposed to be Loyal and Good Subjects, the more by Example you promote Religion, which teaches them to obey : Upon which Account we may truly fay, that You act not the Politician, but, what is much more difficult, like a Wife and Prudent States-Man; You gain the People not by Stratagem, but Example of this Ocasion I

But on this Ocasion I can make use of no great-

er

ee Encomiums than what his Majesty hath been pleaed to Honour You with, in the Preamble to the Patehr which creates you Duke, where He declares, in better Words than I am now Master of, that, as there was no Family in England more conspicuous in Virtue and Piery, fo he thought himself obliged to give Testimony of it, by conferring that Honour on You, which You long before deferved. of But not to enlarge too much on a Subject which the World is fo well ac-

Thum

quainted

The Descention

quainted with I shall need to say no more, than that in Your Illustrious Person wel may see all the just Qualifications of an English Nobleman Iconcentered; fince your Honour is supported not only by Titles, but actions I so that Your Character is pure and unfootied, in alWorld ready to take the least occasion of Calumny and Aspersion of Calumny and Aspersion of Calumny and Aspersion of Calumny and Aspersion

Let me therefore rather admire than endeavour to delineate fo Noble and fo Greata Character; which be it never fo well copyed, must

The Dedication.

must come far short of its truly Illustrious Original.

I shall therefore only add, that all Your Admirers wish that You may long continue an Ornament of the English Nation, and a Standard of Honour and true Nobility; which are more particularly the Wishes of,

May it please your Grace,

Tour most bumble,

and most devoted

Servant,

RICHARD BOULTON.

mult come far there of its cruly Illustrious Origi-

I shall therefore only add, that all Your Admirets with that You may long continue an Ornament of the Engly Nation, and a Standard of Honour and true Nobility, which are more particularly the Willies of,

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PREFACE

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READER.

blued I have on a good tall the Brefaces

Prefixed to the two preceding Volumes, intimated the Reasons briefby, why I have placed the Subjects in the Order and Method they there appear in, I shall take the same Method in this. And,

Land That for the

ceiving

First,

The PREFACE,

First, The Second Volume concluding with those Subjects which are more immediately the Objects of our Senses, viz. Tastes, Odours, and Colours, this Third begins wish what our Author hath faid in Relation to Cold and Heat; to which is added, what he hath delivered concerning Fire and Flame, and those Bodies which chiefly affect our Sight. And as for the remaining Part of the Book, it will be so evident to the Reader, that the Subjects be a Relation one to anoober, that there is no need I should alledge any thing elfento fugget i I placed them in that Order Volumes, intimated the Realons

performed a Task which bath been fo long defired, and which bath been therto been so well accepted by whe Learned; it would be Ingratitude in me not to return them Thanks, for receiving

The PREFACE.

who values himself upon nothing more than that he hath had the opportunity of passing away his Time in their Service, and in contributing his Endeavours in a Work that may be useful in promoting Natural Knowledge: To do which, is not only the Study, but the Diversion of the Candid Reader's very Humble Servant,

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6. Abbette of the Truth of the Cheiltian Religion.

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The DEDICATIO

Learned and Ever Honoured olis

HANS SLOANE M.D.

FELLOW

Your Patronaga HT 140 are for free

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that Royal Suciety, & Which, Your Station

makes you an Uleff. Dut Your Qualifier-S E CIR E T. A.R You

Royal Society.

to You, makes them, the

Learned Sir.

Ratitude it self does not only oblige me to make a Thankful Acknowledgment of Your Favours, but at the fame time, makes the Obligations greater, fince the Opportunity of owning Favours receiv'd from Eminent Men, makes an Addition to them. MOTJUCA!B

And

The DEDICATION.

And if Gratitude be such a Virtue as carries along with it it's own Reward, and also a future Obligation, it is the greater Satisfaction to Me, that whilst I own your former Favours, I lay a Foundation for a second Acknowledgment; But more, that it gives me the Opportunity of folliciting Your Patronage, which you are so free to give to any thing that may promote Natural Knowledge. The Noble Design of that Royal Society, in which, Your Station makes you an Useful, but Your Qualifications a more Serviceable Member.

And as our continual Contributions to the Philosophical Transactions, for which the World is oblig'd to that Learn'd and Royal Society, and in Great Measure to You, makes them the more Valuable; so Your Readiness to encourage my weak Endeavours hath given me sufficient Reason to acknowledge my felf,

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and Most Humble Servant, R. BOULTON.



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PREFACE

READER.

Candid Reader.

A Libough it is the General Consent of all Learned Men, that the Author's Works deserve the highest Esteem amongst all Cultivators of Natural Knowledge; yet, it is as common a Complaint that long Apologies and too frequent Excursions interspers'd through his Writings make 'emless serviceable to Vulgar Readers, who are unable to carry his Sense along with them, when interrupted too often with Digressions, which have little or no Relation to the Subject under Consideration.

And as his Prolix and Complayant Way of Writing is some Disadvantage to Vulgar Readers 3 so there are some, who, the they have Abilities sufficient to extract the Instructive Part, and to pass over his Prolixities, without losing the Advantage of his Improvements; yet they are not backwards to say, that the Reading of Compliments takes up too much time, and they had rather have the Instructive Part, without his long digressive Excuses, since Men, desirous of Knowledge, and less studious of Compliments, need no Apologies to render Knowledge Acceptable, it being sufficiently recommended to Inquisitive Readers by its own Usefulness.

The Consideration of this made me more willing to be concern'd in a Work, likely to be useful to B 2 vulgar

vulgar Readers, and Acceptable to All; being defirous and ready, to take any Opportunity of expressing my Willingness to do any thing, that may oblige the Learned World, or tend to the Im-

provement of Knowledg.

For tho' it is not to be deny'd, but that Compliments are great Ornaments and Arguments of the Candor of a well accomplish'd Author; yet, it is to be allow'd, that, as too many of the finest Flowers may as well intercept the Light of the Sun, as an obscure Cloud, so Compliments may prejudice Knowledge if too frequent, as soon as

less entertaining Digressions.

And if Digressions of any kind be of Disservice to the Reader, and consequently Disadvantagious to the Author, it will be the more acceptable Work, if whilf I end wour to gratifie the Reader, I become serviceable to the Author, in dispersing those Clouds; which, the they may seem Gentlemen-like Embellishments, are not so entertaining to Philosophers, who consider things just as they are withouts Additions of Art or Rhetorick.

Having thus briefly given the Reader the Reafons, which induc'd me to the present Work, I shall in the next place proceed to give an Account of

the Work it felf.

First then, considering that the Author's Design and Aim was not only to improve Knowledge, but, to use a Motto presix'd to one of his Books from the Illustrious Verulam, Potin's promovere in multis, quam persicere in paucis; and since in order to a general intelligible System of Philosophy, he was sollicitous of collecting as many Phænomena as he could, and which might he serviceable in framing such a System; so I have, (that the Author's Aim and Design might not he prejudic'd by an Abstract), taken Care both to Epitomize those things in which he might be saidperficere, and likewise have taken Care not to omit the least Phænomenon which might contribute to the promoting of Natural Knowledge: So that I can justly say, there is nothing in the Author's Works which is not in the Epitomy, except Digressions and Apologies.

And as I have taken Care to omit nothing, so I have been as sollicitousto draw an Epitomy without any Enlargements, which the Nature of the Subjects did not require, or without contract-

ing more than the Subjects would admit.

And further, as where the Author has laid down feveral Historical Truths by way of Notes without Philosophizing upon them, his Design being to promote as well as perfect, I have taken Care to avoid any other Connexion than the Author thought such Notes required, so I thought my self obliged to give an Abstract of the Author's Philosophical Thoughts, where he hath interspers'd them with his Historical Truths, that the Work might be more perfect.

So that the Reader will have in the following Volume, which contains about 30 Sheets befides the Cuts, as much Matter as in the Original takes

* B 3

up near 200 Sheets, which will not only carry this Advantage with it, that what before would have taken up near two Months time in reading, may be read in a Week, but be will likewise purchase Philosophy at so cheap a Rate that upon that Account it will undoubtedly be more acceptable, the Price of this Volume coming far short of Forty Shillings, which the Books Epitomiz'd in this Volume almost amount to. But what is the greater Advantage is, that fo much Knowledge compris'd in fo small a Compass, will be more easily account'd by young Philosophers, who in larger Volumes are apt to forget what they left at the Beginning, beforethey arrive at the Bud of them : But by this Epitomy, a System of Philosophy being brought, almost before the Eye at once, it will be more easily Swallow'd and digested.

But whilft I am confidering the Advantages which the Reader will receive by the Abridgment, I am told by the Bookfellers, that it is likely to meet with some Disadvantages upon another Account; for it being common for Buyers to estimate the Value of a Book by the Bulk, they may think too great a Price put upon this Volume; And therefore, the Bookfellers think it necessary that I should acquaint the Reader, that cheir Reason will take off that Objection; for besides, the Dearness of Paper, and the Number of Cuts contain d in this Volume being so chargeable as to amount to a fourth Part of the Charges of the Book; it is boy'd that the Usefulness of the Cuts

will

will excuse the Dearness of it; for to have Printed an Abridgment without em, would have made it dearer, the of a less Price, the Cuts being as requisite to Illustrate the Author's Works, as Maps in Geography to render Accounts of the Terraqueous Globe more intelligible.

Thus much being faid in favour of the Bookfellers, I shall now proceed to give a brief Account of the Method I have taken in this Volume, referving a further Account of the subsequent Vo-

lume till the Publication of it.

And first, considering that it is the usual Method in Systems of Philosophy, to begin with Generals, and thence to proceed to Particulars; and likewife to lay down Principles in Order to Explain the feveral Phanomena of Nature by those Principles , I have in compliance with so reasonable a Method, first laid down the Doctrin of Forms and Qualities , and the Principles by which those Qualities are divertified, from whence likewife arife those various Forms from whonce each Particular Quality is deriv'd; and because Subordinate Forms depend on the same Principles, and differ only from simple or complex Forms in reference to their Union in Compound Bodies. I have likewise adjoyn'd an Account of them, which Doctrin of Forms and Qualities is further Illustrated by Experiments and Observations annex'd by our Author for that purpose : And because there is an Affinity between those Experiments, and those made by our Author on Salt-Petre

Petre to them I have annex'd an Abstract of his Effay on Salt-Petre, which is not only a farther Illustration of the Doctrin of Forms and Qualities, but being likewise of equal Force in Illustrating what he delivers concerning those General Affections of Matter, Fluidity and Firmness, I have in the next place laid down what he Teaches concerning those more Cathalick Modes of Matter; and fince our Author in his Chapter of Fluidity bath likewife taken notice of the Superficial Figures of Fluids, I have to that added what is delivered concerning the same Subject in the Philosophical Transactions, and because the Firmness of Bodies is faid to proceed from a Rest in their Parts, I have subjoyed to that an Estay of the Motion of the Parts of Solids : And to conclude the first Book, which Treats of the most General Affections of Matter, I have added an Account of the Effects of Languid Motion, and the Propagableness of it through those Catholick Mediums, viz. Fluids and Solids.

And these more Catholick Phænomena of Nature being Explain'd in the first Book, to distinguish 'em from Qualities more Particular 3 in the Second Book I begin with the Doctrin of Particular Qualities, which do not only depend on the Motion or Rest, Shape, Size and Texture of Matter, but likewise on the Structure of the World as now-Constituted, and the Laws of Na-

ture at now Establish'd.

And because That Part of the Universe con-

tain'd in Our Vottex, is the Subject chiefly of the following Sheets, having first begun with an Introduction to Particular Qualities; I proceed to consider, first the most General Observations in the Earthy Region, and from that proceed to consider Submarine Regions, after which, by way of Introduction to the Region of the Aix, I have added an Essay of the Natural and Preternatural States of Bodies, and Particularly of the Aix, from which proceeding to Experiments made in the Aix, those closing the first Volume; In the second Volume I proceed to what he says further relating to the Aix, in which I shall give a surther Account of the Method taken in that.

Having thus briefly given the Reader an Account of the following Method, I shall without detaining him any longer, subscribe my self the

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Candid Reader's

Very Humble Servant,

R. BOULTON.

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INTRODUCTION,

Representing the Grounds and Excellency of

CORPUSCULAR PHILOSOPHY.

I AVING in the Preface given the Read der an Account of the following Sheets, the Grounds and Excellency of the Corphfular

Philosophy, as deliver'd by our Author.

And first: It hath this to recommend it above all other Systems of Philosophy, That it teaches us not, as the Doctrin of the Epicureans does, that the World was made in an Infinite Vacuum, by a Cafual Concourfe of Atoms; nor as the Cartefis ans, That Matter first put into Motion by GOD, convened into a World, as now constituted, by Laws Mechanical only; but it allows the Omnipotent Creator a greater share in the Works of his Hands, teaching that the Motions of the small Parts of Matter, which compose the Universe, were guided by that Wife Architect, who when he had constituted the World, establish'd the Laws of Nature. So that we only endeavour to explain those as now constituted, and how they are Mechanically carry'd on.

In doing of which, it accounts for the several Phanemena of Nature, by Principles more intelligible and clear, than the Doctrin of the Periparenich; since it is much more easily understood

what

what I mean by Motion or Rest, Size, Shape, Order, Situation, and a Contexture of the Parts of Matter, than by fanciful Ideas represented by the Doctrin of Privation, Substantial Forms, and their

Eduction, de.

Nor hath our Hyperhefis a less Advantage over the Hyperhanical Principles of the Chymifis, since it accounts for several Phanomena, which they are at a loss in; as Eclipses of the Sun, which are brought on, and remov'd by a Local Motion of the Interfering Body, and those others concern'd in the Phanomenon: Or, to use another Instance, it is easily understood, that the Image of a Man cast into the Air, by a Concave Spherical Looking-glass, are more Naturally accounted for by a Refraction of the Rays of Light than any Hypestatical Principles.

But besides the Intelligibleness of our Principles, it is a farther Recommendation, that none are more Primary than Matter and Motion; which is the first General Assection of it, nor can any be more simple: None more Primary, because had the same Parts of Matter been always in the same Place, they could not be diversify'd; therefore Motion was primarily necessary. Nor could any be more simple, because neither could be divided into Parts of a different Denomination; since all Matter is equally Matter, and all Motion must bear the same Title, consider'd barely as Motion.

And as none can be more Simple and Primary, so none can be more Comprehensive; since Motion, Size, Figure, Order and Texture, may be diversify'd thousands of ways, and as whole Libraries are made of Twenty-four Letters, so the several Phanomena of Nature may be explain'd by the several

The Introduction.

Varieties of Textures, and other Differences, arising from the various Changes our Principles

are subject to.

Nor are the most Obvious Phenomena of Nature alone explain'd by our Hypothosis, but those Qualities esteem'd Occult ones, since the Particles which are concern'd in such Compositions, as abound with occult Qualities, are subject to the same Laws, and capable of the like manner of Action; tho' their Parts are so Minute, as to make

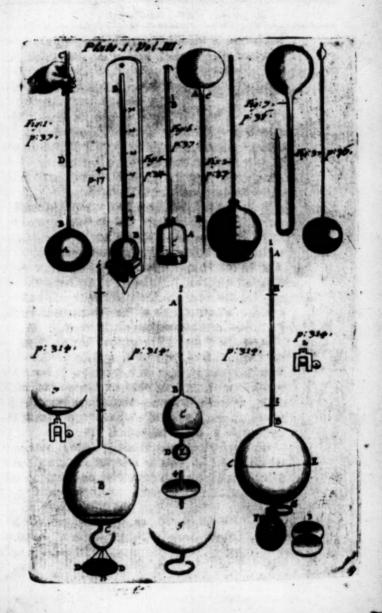
their Modes Operandi indifcernible.

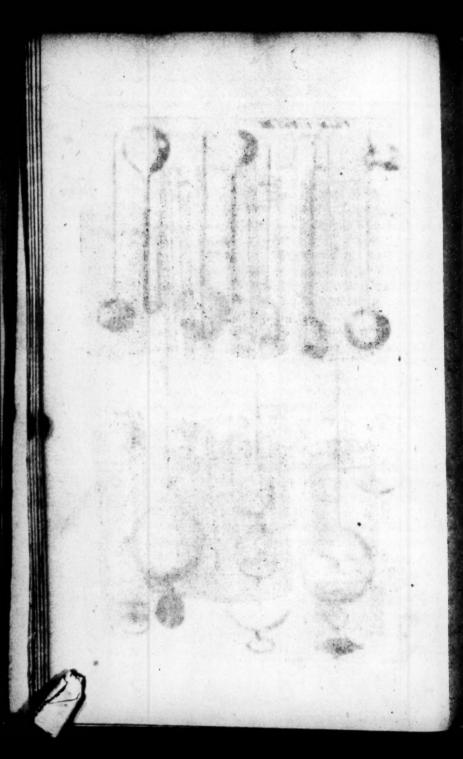
But what is still more an Advantage in our Hypothesis, is that it files not to an unknown Power, as a Plastick one, or an Anima Mundi, whose Operation is not known, but gives us a Mechanical Account of Things; for the former gives no more Satisfaction, than if one were told, that a Watch tells the Hours of the Day, because made by such a Man; whereas the true Reason is, because the Parts so plac'd together are in Motion.

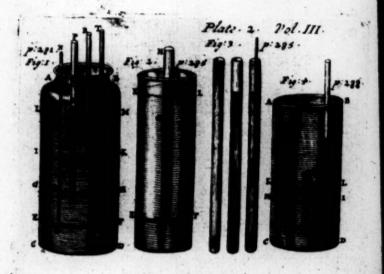
And the same Instances may serve to shew us the Desciency of the Hypostatical Principles: Besides Ingredients by a bare mixture, being able to effect nothing, nor able to work upon each other, without Motion; those Principles themselves, appear, to be only different Modes of Mat-

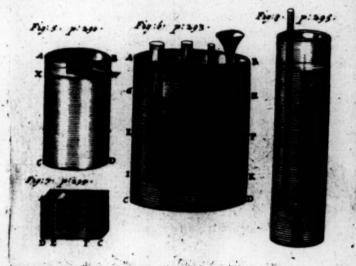
ter, vary'd by our Hypothesis.

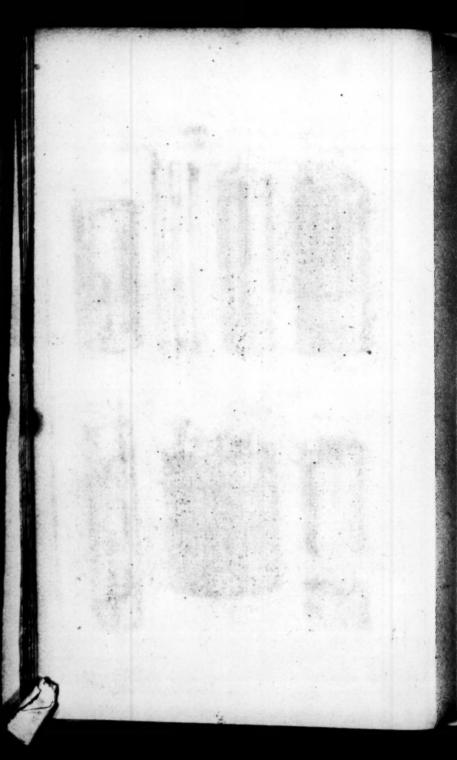
To conclude, There is not any one Phenomenon which any Hyperhesia is able to explain; but a more intelligible Account may be given by the following.

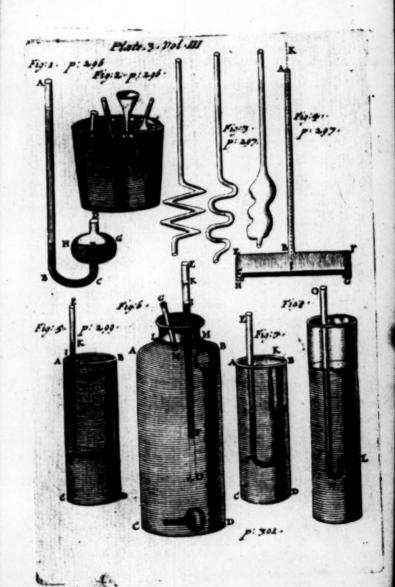


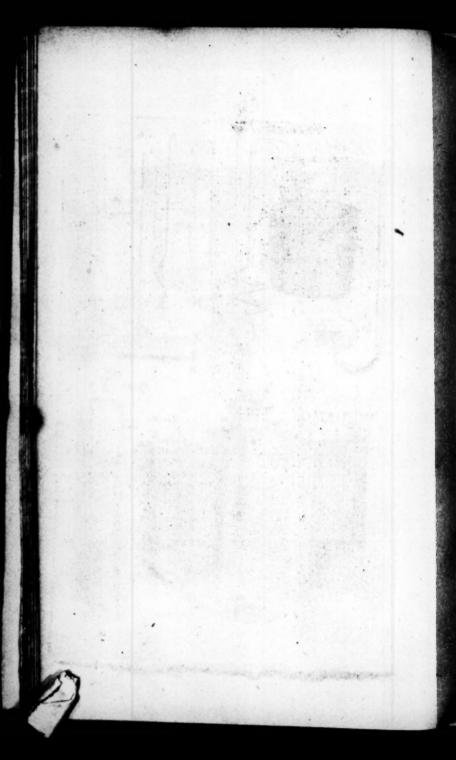


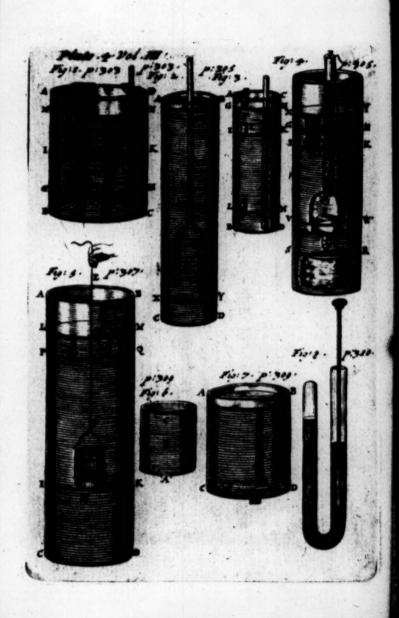












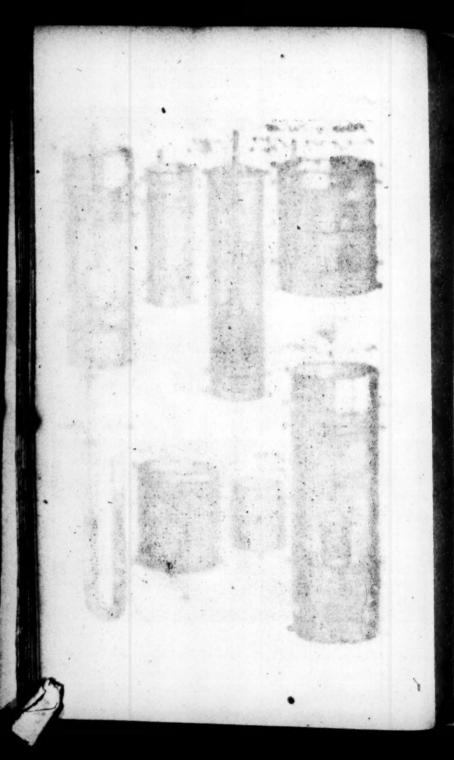
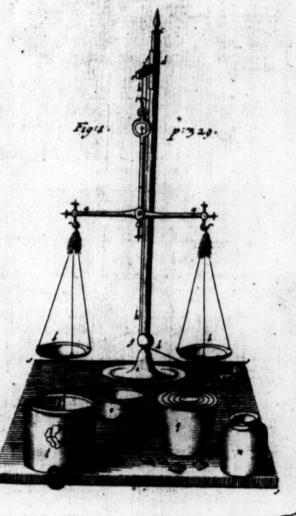
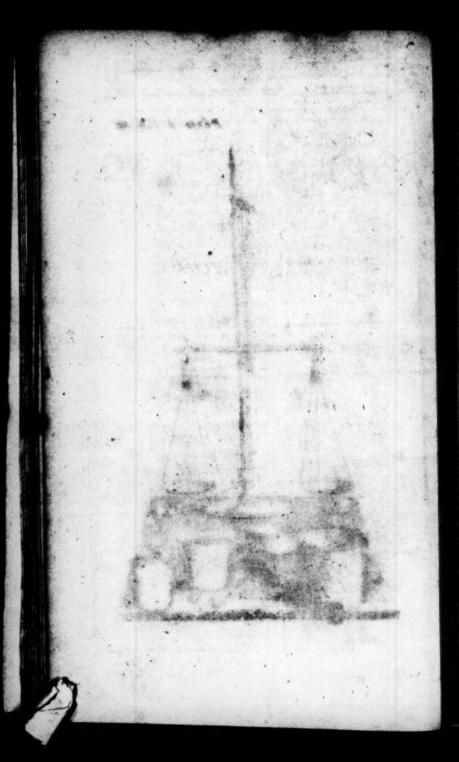


Plate . 5 . Vol: III.





RKS

Of the HONOURABLE

ROBERT BOTLE, Efq;

EPITOMIZED.

An Appendix to BOOK IV.

CHAP. I.

Of the Mechanical Production of Cold.

O make it appear, That Heat and Cold, Experi-which are generally esteemed two of ments conthe most active Qualities, may be me- dechanical chanically produced or destroyed by Origin of bare change of Texture, or by Alterations Cal therwise mechanically brought on, without the ffistance of the Peripatetick Doctrine of Subtantial Forms, or the Hypostatical Principles of the Chymists; I shall subjoin the following Experiments.

EXPERIMENT I.

A filation of Salarcomiss. Having dislov'd Sal-Armoniack in four times its quantity of Water, whilst the Mixture was a stirring, and the Sale dissolving, the Water acquir'd such a degree of Coldness as to congeal Water, with which the Bottle was wet on the outside, into Ice; but after a Dissolution of that Salt, the Coldness gradually declin'd.

EXPERIMENT IL

To try whether the Coldness which the former Mixture acquir'd, did not rather proceed from the Effect which the Water had on the faline Parts than on the Difpersion of those Saline Parts through the Water; I immerg'd a Thermoscope in Water, which was so warm a to make the Spirit of Wine ascend; but the fame Thermoscope being removed into Powder of Sal-Armoniac warm, it ascended much faster; yet the Weather-glass being conveyed into the Liquor again, and the Salt poured into it, it speedily began to subside, and funk a Division and & below the Mark it flood at in cold Water, remaining at that Station a confiderable time. And the same Experiment succeeded when trved a second time.

EXPERIMENT III.

Having immerfed a Thermoscope in Spirit of Salt, I pour'd Spirit of fermented Urine leisure by upon it, and observ'd, that the Mixture by a poutual

mutual Conflict growing hot, fenfibly raifed the A Then Spirit of Wine; which being done, and a Salt & obtained from the evaporated Mixture, not Mixture much unlike Sal-Armoniack, it was carefully dried, and being put into Water, in which a Thermoscope was placed, upon its disfolution, whilit it was ftirred about, the Spirit of Wine in the Weather-glass gradually subsided.

EXPERIMENT IV.

Having poured as much rectify'd Spirit of Roch Allom into a wide mouth'd Glafs, as was fufficient to cover the globulous part of a Thermoscope, Rech when the Spirit of Wine was equally cooled acc. with the Air about it, we poured into it a volatil Salt, obtain'd by Sublimation from Sal-Armoniack, and a fixt Alcali; and the upon the joint Action of these two Bodies, a considerable Noise was raised, with Bubbles and Froth; yet the Spirit of Wine began to subside, and continued to do fo, 'till the Spirit of Allom was wholly glutted with the volatil Salt, the whole Descent being the length of an Inch.

From this Experiment and the foregoing it appears, That when Alcalies and Acids produce Heat, upon a mutual Conflict which enfues their Mixture, they have not that Effect precisely confider'd as fuch; fince it is evident, that an urinous Salt mixed with an acid Spirit, viz. of Roch Allom, produces Coldness; and not a true

Effervescence.

EXPERIMENT V.

Mark Co.

One part of Oyl of Vitriol being shaken together with twelve parts of Water, the Mixture acquir'd a little Warmth; but when it was cool being poured into a wide-mouth'd Glass, and a Thermometer immerfed in it, when the Liquor in the Thermoscope was equally cool with the external, we poured in a fufficient quantity of Sal-Armoniack to glut the Acid: The effect of which Mixture was, that upon a cold Ebullition the Spirit of Wine descended an Inch.

EXPERIMENT VL

Tho' Salt Peter usually produces a Coldness wed by a in Liquors, yet eight Ounces of it being mixed Mixture of with fix of Oil of Vitriol, the Mixture acquired oyl of a confiderable degree of Heat, emitting Fumes copionily.

EXPERIMENT VII.

The effet of Though Gun-powder be a Body to inflammable, yet it evidently imparts a Coldness, if mixed withWater, with Water. If a small quantity of Oil of Vicriol be mixed with the Salt formerly made use of, before the Oil hath been mixed with Water, it acquires a considerable degree of Coldness.

A Digression about Potential Coldness.

Potential Coldness is usually looked upon to Perential be a Quality fo absolute, as not to be explicable Caldness without the Doctrine of Substantial Forms : But cally exit will eafily appear, That it may, without any plained. great difficulty, be clearly explained by Mechanick Principles; if we consider, that the Figure, Shape and Texture of Bodies may be fo contrived as to leffen the usual and natural Agitation of Humors about our Senfory, and confequently, the Perception of this Imminution. may cause fuch a Sensation as is usually term'd Potential Coldness; which account being allowed, it will follow, That Potential Coldness is only a relative Quality, depending on the dispersion of the Agents through the Bodies to be cooled by them : According to which Notion, the cold Fitts in Agues may eafily be conceived to arife from an Intermixture of the Parts of some clammy Matter, which before a Diffolution, were unable to cause any considerable Effect in the Mals of Blood; but presently after being mixed with the Blood, produce such a change in the Motion of its Parts, as affects the Senfory with such a Sensation as is usually esteemed Potential Coldness; which Sensation may not only be so produced in Agues, but by a like Cause in other Distempers, and in several Parts of the Body, as in Hypochondriack and Hysterical Cases. To render which Account more probable, I shall fubjoyn, That I have learnt by the Effects of Poyfons, that the small Parts of them being in-B 3

ter-

terperfed through the Parts of Humors previonly disposed may cause a notable Refrigeration; And I my felf have prepar'd a penetrating Chymical Liquor, a Drop of which being given to an Animal, would caft him into a feeming Sleep; and a little larger Quantity, being by Mischance applyed to an akeing Tooth, gave the Person a fort of trembling, and almost an universal Refrigeration. And that Coldness may be produced by the Mixture of some Subtile Parts of Matter with the Mass of Blood, appears from the following Histories. Famulum babui (says Benivenist, Cap. 56. Abditorum apud Schenk. Lib. 7. de Penen. Obf. 24.) qui a Scorpione i Gus, tam subite ac tame frigido Sudore toto Corpore persusus est, us algentissima Nive atque Glacie sese opprimi quere-retur, verson cum algenti illi solam Theriacam, ex Vino potentiore exhibitifem, illico curatus eff.
And to this I shall add another, related by Amatus Lufitamus, Cent. 6. Obl. Vir qui a Scorpi one in Manus digito punctus fuit, multum dolebat, & refrigeratus totus, contremebat & per Corpu dolores, Cute tota quasi aus puncia, formicantes patiebstur, &c.

What Re rigeration

Whether fuch Refrigeration depends on a fort of Coagulation of the minute Parts of the Blood, or whether it may be produced by a different Determination of the motion of the Parts of those Liquors as to the Lines they move in, I shall not now examine; but shall rather offer it to be confidered, fince the internal Constitutions of feveral Parts of the Body are different from each other, and fince the Size and Textures of feveral Agents are also various, whether they may not upon that account have different Effects upon



diffind Parts of the Body, for all the Qualities of fuch Agents do not wholly depend on the Action of the Corpufcles of the Medicine only; but depend on some adventitions Qualities, which they acquire by being mixed with particular Humors and which they may dispose to be more or less worked upon, by the other Efficients of Heat or Cold.

And these Conjectures may not be render'd a little probable, by observing, That the' Spirit of Wine inwardly taken causes Heat; yet externally it abates the Heat of inflamed Parts; but hath different Effects on a tender Eye: And though internally five Grains of Camphire may diffule Heat through the whole Body, yet ex-ternally it is used in refrigerating Medicines.

How far these Observations may be of Service in determining whether Camphire, &c. be hot or cold, I shall leave to Physicians to consider, and shall here only offer in Proof. That Potential Coldness is only a relative Quality, the following particulars, viz. That from the VI. and VII. Experiments it appears, that according to the Dispositions of Bodies to be worked on, the Agent may have different Qualities: As Fumes of Lead may congulate Mercury, tho' it bath not a like Effect on other Liquors : And further, although Sal-Armoniack and Nitre be, when separate, cool, and tho' the latter melted in a Crucible takes not Fire of it felf, yet upon an addition of Sal-Armoniack it flashes vehemently. But I shall leave this Digression, and proceed to Experiments about Cold.

EXPE-

Oyl of Pl. trial poursell upon a Salution of

To make it appear, how much Motion and Texture may contribute to the Production of Cold, we gradually added twelve Gunces of Water to an equal quantity of Sal-Armoniaek; and whilst upon a Dissolution of the Salt, the Water became cold, we poured in twelve Gunces of Oyl of Vitriol, upon which the Mixture became hot; where it is not a little strange, that though Sal-Armoniaek in either of these Liquors produces Cold, yet a contrary Effect should happen upon its Mixture with both together. The Reason of which could be no other but that the Heat produced by the two Liquors overpowred the Degree of Cold, which the Salt was able otherwise to produce.

or cold I mall leave to thruciane to consider, and fine it X on WA MAN A 30, File Possessial

The Elects of the same Mixtures are so uncertain sometimes, that I have observed, that having placed a Thermometer in eight onners of Spiris of Verdigrease, and graduelly put in two purces of Sale of Tartar, after some time, the lagredients having worked upon each other with a copious Froth and a bissing Noise; the Bottle was something warm, and the Liquor in the Thermometer raised: Yet another Sale being mixed with Sale of Tartar, and Spirit of Verdigrease prepared without Spirit of Vinegar, and Spirit of Wine poured upon it, instead of an Incalescence, a considerable degree of Coldness would be produced.

EXPE-

we have obleve'd in Camphire reduc-EXPERIMENTAX

ta concinile this Oyl of Vitriol and Water shaken together mon an Atidities of Sal-Armoniach, acquire a fort of Gooleefs but If Oyl of Vitriol and the Salt be first mixed, upon an Affusion of Water they become hot: And the Salt of Tarter grows hot in Water, yet the Capit Mortugus of Salt of Fartar and Cinnabar, diffill'd in a frong Fire produces no Heat, notwithstanding a hiffing Nolfe like that of Quick-lime fucceeds its Immersion.

That the artificial Production of Cold may Aceincibe obstructed by an Indisposition in the Patis dont Diffeent, to be acted on by the grand Efficients of friest the Cold. I have learned by feweral Observations and particularly by noting that the Oyl of Vitriol be so fiery a Liquor, as in some a measure to have the Effects of Fire it felf, and die to dissolve Ice fooner than Spirit of Wine; yet a Pound of choice rectified Spirit of Wine being put into a Borrie, except a little at the Top, it was wholly coagulated into a confiftent Mais like Ice; notwithstanding the Glass stood in an Elaboratory in which that Oyl was never at any other time observed to congeal. And this Phenomenon was the more remarkable, because the Oyl continued in that state, when the Weather was too moderate to be the cause of such an Effect; on the contrary I have observed, that Oyl of Annifeeds, which usually coagulates with a less degree of Cold than Water, continued undi-Burb'd and transparent, without the least Coagulation, in a very frosty Scason; and the like

we have observed in Camphire reduced to a

Oyl by fome Nitrous Spirits.

But to conclude this Section; If Heat depends on a brisk agitation of the Particles of the Hamours about our Senfory, and if Cold be an Effect of a lefs degree of Motion than that about our Senfory; it appears that an Imminution of that Motion which is requifite to produce Heat. is fufficient to cause the contrary Quality, viz. Coldness, And the Gold seems in such a Sente a privitive Quality, yet in as much as the Agent which causes that Imminution acts positively upon the Parts in motion; it may be efteened a positive Quality, the in respect of our Sensory it is but a relative one, as luke-warm Water will appear hot or cold, as the Hand immerfed in it hath either been exposed to an intente degree of Cold or Heat. And indeed the princh pal miftakes which fometimes occur in Discourse concerning Cold, happen upon the account of the ambiguity of that Exprellion, which fometimes a afed to fignifie the Idea imprinted on the Mind by the advention of an external Object; fometimes for an Imminution of fuch a Motion s causes Heat, and sometimes for the Object upon a contact of which we perceive Cold.

CHAP. II.

Shewing, that not only our Senses, but common Weather-glaffes, may misinform us about Cold.

"HO' most Philosophers have hitherto taken Neither on the Testimony of our Sensories for the Weatheronly Criterion, by which they estimated the de-glasses, ingrees of Cold; yet fince Cold is, in respect of falli our Organs, only a Relative thing; and fince degrees of it hath fensible Effects on other Bodies, which Cold. are affected by more minute Variations than our Senfories; it may not be amis to estimate the degrees of it, by the changes it causes on those Bodies that discover it's flighter Variations, as well as by the affiftance of our Senfes; fince neither our Senfories alone, nor common Weather-glaffes are too confidently to be relied on in judging of the degrees of it.

For Cold being a relative Quality in refpect of our Senfories as the Difpolition of the Organ varies, so the same degrees of Cold may feem violenter or more remis; as it is observed in hot Baths, the most remis degree seeming hot to those that come out of the open Air, yet Cold and Chilling to those that come out of a hotter Bath into that; the Reason of which appears to be, that the Parts of the cooler Bath are more briskly agitated about our Senfory than the Ambient Air; but when we come out of a hotter Bath, they being less agitated in Respect of that, causes a Cold Sensation by altering and checking the

briskly agitated about our Senfories.

But our Senfories may rot only misinform us in fuch Cases, where they evidently appear to be differently tempered in respect of those Objects; but sometimes, when those Variations in the Dispositions of our Sensories are Caufed by unfuspected Agents, or infentible degrees; fo we perceive the Air in a celler much Colder in the Summer, when Bodies accustomed to a warmer Air descended into it. Nav fometimes we judge amiss of the degrees of Cold, when we think our Senfories unaltered; to Air blown out of a pair of Bellows upon the Senfory, by penetrating into the Pores and retardating the Agitation of the Humors, feems Colder than before, yet when blown upon a common Weather-glass, that motion enables it not to depress the Mercury.

Belides, fometimes we may be more fenfibly affected with Cold, when it depends not on the Qualities of the Air in general; but either on some Steams which are endowed with frigorisck Qualities, as Opium externally applied; or on some chilling differenced Humor in our

Bodies.

But further, sometimes Bodies appear colder to our Sensories than to a Weather-glass; because the former are more affected by the Density and Penetrancy of the Parts. So water hath appeared cold to our Bodies, when by a nice Weather-glass I could not discover, that it was Colder than the Air.

Soil Senteden by affering and castains? Ho.

See Plate

Amongst

Amongst several Tryals made with these Weather-glasses, the following were remarkable.

Having caused a Glass-Egg with a Stem, (such as Fig. 1. Plate 1. Delineates,)to be blown at a Lamp, the Stem being dipped in Water, admitted into it a Cylinder of Water about half an Inch long, which, when the Pipe was erected, would subside to the Bottom of the Cylinder, just where it rises from the Egg, and there it would stand; but if the Glass-Egg was immersed wholly in Water, or but half way in Quick-silver, the Water would ascend up to the middle of the Cylinder, and subside again when taken out.

In this Experiment several times repeated, I observed, That when the Glass-Egg was suddenly removed out of the Water, and immersed in the Quick-silver, the Cylinder of Water would be railed higher; but if it was first immersed in Quick-silver, and thence removed into Water, it would subside, but not near so much as in the open Air. These Tryals were made the 26th of Jame, the Weather being moderate. But being repeated another day when it was windy and rainy, the Aqueous Cylinder upon the immersi-

on of the Thermometer subsided.

June 27 in the morning, the Aqueous Cylinder would subside when the Thermometer was immersed in Water; but ascend when it was depressed into Mercury; yet when the water had been kept in a warm Room some time, till it was as warm to the Touch, as the Quick-

filver, they would both of them immediately

raife the Mercury in the Pipe.

The like Experiment being tryed in January in Frosty Weather, the Internal Air being of an equal temper with the External; when the Thermometer was immerfed in a shallow Vessel of Water, the Aqueous Cylinder was raised half an Inch; and when it was immerfed in a deeper Vessel, it was raised as high again; but soon subsided when taken out into the free Air. From whence it appears, That we may be differently informed of the degrees of Heat and Cold, when we Employ out Organs of Touch, and when we make sile of proper Instruments.

On this occasion I shall subjoyn, that not only Water, but moss Vapours in the Air may canse it to seem Colder to our Sensories, than commonly Weather-glasses discover it to be. And tho it be generally agreed, that a Themometer only more exactly measures the Effects which Cold hath upon it and our Sensories; yet I my self have taken notice, that at the same time the Weather hath seemed cold to me, when the Weather-glass agreed not with the Information my Senses gave me, which, that it did not proceed from my insurance was apparent; since others were sensible of it at the same time.

From what hath been faid, it appears, That it is requisite to take notice when Birds and other Animals, whose Perception is more delicate than ours, seem to be affected with Cold, and likewise to examin the degrees of Coldness, as well by Experiments as by the Touch.

For a further Confirmation of what I have delivered on this occasion, I shall add what Mar-

tinius

chierafe, fays, speaking of the Air of that Populous Country; his words are thefe. Ad Cati ique temperiem quod attinet, majus in bac Provincia frient oft, quam illius poscat poli altitudo; vix enim illa excedit gradum secundum supra qua-dragesimum; O tamen per integros quatuor sepe Manses Flumina omnia adeo duro concrescunt gelu, ut currus equosque ac gravissima etiam onera glacies ferat, imposie es securissime transeant: Ex iis etiam ingentia glaciei frusta excinduntur que in figuram aftatem ad delicias fervant. His Menfibus ommes Naves ita in ipfa Glacie defixa funt, ut progredi nequeant ubicumque illas frigus occupat (quod certo certius circa medium Novembris ingruere solet)per quatuor illos Menses immota ibi perstare coguntur, noque enim resolvitur Glacies ante Martii um ; bec plerunque Glaciei concretio uno fit die eurs non mili pluribus fiat Liquefattio. To which be adds what is more for our present purpose, Omnino illud mirum, tantum non videri aut fentiri illud frigus ut Europeos ad bypocausta subeunda videatur posse cogere, aut in Europa ad Glaciem pro-ducendam sufficere, unde ad subternaneas illie exbalationes pro barum rerum Causis indagandis o-

But tho' I have urged the necessity and usefulness of Weather-glasses, as preferable to the Informations we receive from our Senses; yet, tho' they are not obnoxious to the same Causes of uncertainty, they are apt sometimes to deceive us; since in common Weather-glasses, besides that the external or internal Air may be rarised or condensed by Heat and Cold, the incumbent Atmosphere being contiguous to the

fuf-

As Experimental PE (tor)

inspended Liquor, it may be boyed up by a additional Gravity as well as Heat, in the Atmosphere and Pice 2016; as we have experienced by a statical Baroscope, whose Ballance would turn with the 500th part of a Grain. And likewise by conveying a common Weather, glass into the bottom of a deep Pit; and at another time by raising it up to the top of a Church or Steeple, and comparing it at the same time with a more exact. Thermometer; for, by this Method, it appeared, that the rising and falling of the Water in the common Weather-glass depended not on the temperature of the Air at to Heat or Gold, but on the different altitude of the Atmospherical Pillar of Air incumbent on the Water.

on the Atmospherical Pillar of All Incombes on the Water.

But basides the Gravity of the Atmosphere, there may be other Gasies of the ascent and descent of the Liquor in common Weather-glasses well as Heat and Cold For not to urge, that the the beight of the fame Atmospherical Pillar of Airshould seem unaltered, the Weather-glasses of Airshould seem unaltered, the Weather-glasses of Airshould seem unaltered, the Copious dispersion of Vapours and heavy Steams through the Air, and also may be diminished upon a precipitation of those by Dew or Rain; which Effects may perhaps be fally attributed to different degrees of Heat or Cold. To be farisfy'd of the truth of what I have here hinted, I tryed the following Experiments.

Se Note 1.

I took two Weather-glaffes of a more than ordinary length, the divisions of one of which were half luches, and those of the other not much less. The one, which was furnished with

good

good Spirit of Wine (see Plate 1: Fig. 3.) was fealed. The other (see Plate 1. Fig. 2.) was not fealed, but was fo contrived, that the Air being that up in the lower part of the Inftrument, might rife with Heat and fall with Cold. In these Thermoscopes I observed, That in that which was fealed, the Liquor regularly afcended in warm Weather and subsided in cold: But in the other, there being a little hole left open at the top, it was remarkable, That tho' when the Atmosphere continu'd to be of the same weight, it would regularly rife and fall; yet when the Gravity of the Atmosphere was alter'd, it would not exaltly correspond with the other; for as when the incumbent Pillar of Air was heavier than ordinary, the Liquor would not be raised high enough by Heat, the pressure of that Air refifting it : So, on the other hand, when the Atmosphere was lighter than ordinary; the Liquor in the unsealed Glass would rise too high. So that by comparing the two Thermometers together, I could tell, whether the Mercury in the Torrecellian Tube (see Plate 1. Fig. 4) was see Plate 1. rifen or fallen, and Vice verfa; the riting and Fig. 4 falling of the Mercurial Cylinder one quarter of in Inch; usually fignifies a great disparity betwixt the ascent or descent of the Liquors in the two instruments.

The difference betwixt the height of the Liquors in the two Thermometers last Night, was but or 2 Divisions To day, the Barometer making t evident, that the Air was much lighter; the liquor in the unsealed Thermoscope was at 58. Tho' in the other, the number of the Divisions it tood at was but 41; yet a Week ago, when the Mer-



Mercury in the Barometer was much higher, and the Liquor in the sealed Weather-glass stood at 46, that in the other was no higher than 27. So that in a Week's time the Liquor in the sealed Thermoscope descended 5 Degrees, and that in the unsealed one ascended 31.

At another time I observ'd, that when the Mercury in the Barometer was higher than ordinary, the Liquor in the sealed Glass stood at the soth Division, but in the other it was fallen to 32 in warm Sun-shiny weather; so that an unheeded change in the weight of the Atmosphere, may have a greater power to compress the included Air in an unsealed Weather-glass, than a considerable degree of warmth may have to dilate it; and consequently it may happen in an ordinary Weather-glass, where the Air is included at the top, that the pendulous Water may rise in warm weather and fall in cold weather.

been faying, I shall add, That even Yester-night I observed, that the Mercury in the Baroment being at 39 Inches, the Liquor in the sealed Barometer was at the 40th Division, and in the other at 39½; but this Night the Mercury being raised t of an Inch, the Liquor in the sealed Glass rose to 45, the other being depressed to 34½. The Night following, the Mercury being raised t of an Inch, the Liquor in the sealed Glass continued at the 40th Division; the Liquor in the other in two Days time having been depressed to the 17th, that is 23 Divisions. Two or three Days after, the Mercury being risen to 30 Inches, the Liquor in the sealed Glass

was at 41; the other was depres'd below the oth Division, being 33 Divisions lower than the other.

The Day after the Mercury continuing at the fame height, and the weather growing much colder, it fubfided uniformly enough; that in the fealed Glass subsiding to the 22 and the other below the lowest Mark of all: Which difference still continu'd fo great betwixt the Lignors of the two Thermometers, because the Air to Day was very heavy; whereas at another time when the Atmosphere was not so heavy, and the Mercury was suspended at 29 Inches and less than a half; the Liquor in the Hermetical Glass stood at 34 when the Liquor in the other was not below 41.

But once I observ'd the difference betwixt the two Weather-glasses to be greater than any I have recorded yet; it being near 45 Divisions. And a few Hours ago I observ'd, when the Mercury in a Baroscope had risen above 4 of an Inch higher than it was the Night before, the Liquor in the mank of the Weather-glass was depressed above an Inch below the surface of the ambient Liquor in the Viol, and in the Night was fo far depressed, that a Bubble of the external Air made its way out at the bottom of the Tube, and joyn'd with the common Air in the Cavity of the Viol; an Effect which the coldness of the Season could not give one hopes to expect: the Pipe in which the Liquor was contained being so Inches long.

CHAP. III.

Containing some new Observations about the Deficiencies of Weather-glasses, together with some Considerations touching the me or Hermetical Thermometers.

Confider ations of the deficiency of Weatherglasses.

T O excite Men to greater Curiofity and lad dustry in making Thermometical Experiments, to what I have already said; I shall all the following Considerations: And

Confiderati-

First, In order to make our Discourses, what we Communicate to those that are at distance more satisfactory; we are not provide with a Standard of Cold, to estimate and juda of the degrees of it by: For our Senses are by no means proper Standards, fince the fame Bo dy that feels Cold to one is not of the fam degree of Coldness to another; nor can The mometers be given as Standards: Since they on shew, how far the Air recedes from that degrees Heat or Colndess wherein they were made, as give us no fatisfactory account of the temper the Air at other times; nor do they inform how to express it, so that it is a very difficu thing, if not impossible, to give a true Stands of Coldness. Besides it is a Quality, for who differences there are very few diffinct Name there being a great many Intermediate degree of Cold, betwixt Luke-warm and Freezing; as well as feveral degrees of each of the Qualities, for which we have no Names affigned And indeed, the Observations made by a Wo ther-glass, are so confined, that if a Gla chang

chance to crack, or some Bubbles of Air get in; we are forced to look out for another instrument, as a Standard of the Air's Heat or Coldness. And further tho' it be not difficult to include in the Cavity of a Weather-glass, another Body instead of Air; yet it cannot be done, without being liable to receive Impressions from the Atmosphere, when first put up.

But tho' it be difficult to get a Standard of Cold for to judge of it's degrees by, yet I have fometines thought, That Oyl of Anifeeds, which is coagulated in Cold and thawed again in warm

Weather; might enable us to make two Thermometers exactly correspondent: If the ball of the Thermoscope being immersed in Oyl of Anifeeds melted, we observe what station the Spirit of

An Ingenious Gentleman propos'd to lettle a Standard for Weather-glasses, by observing the Effects of such a degree of Gold as is requisite to freeze Distilled Water, and it may be ad-vantageoully made use of when strong enough to freeze Water.

Wine stands at, when it just begins to coagulate: But in doing of it we are to observe, That the Cavities of the Glasses and the Quantity of the Spirit of Wine ought to be as equal as can be; otherwife the fuccess will be much more uncertain. Which way of Estimating Weatherglasses, tho it be not so certain as unquestionably to answer expectation, yet it may be of advantage to come as near as we can to certainty. But

Secondly, There is unaccurateness in measu. Considerati. ring of Cold by Weather-glasses which may be mihe 2d. avoided, yet is not; fince sufficient care is not taken, that the Diameters of the Cylinders are exact all along, from one end to another, nor

that

See Plate 1. Fig. 2.

that there he a certain Properties, betwist the Diameter of the Cylinder, and that of the Pipe, Besides, open Weather-glasses may be more Commodiously contrived for Thermometrical Experiments than those that are commonly made use of; (See Plate 1. Fig. 2.) In which the mouth of the Vial being so closed with cement or wax, that the External Air hath no communication with it but through the Pipe; upon an Expansion or Condensation of the Internal Air, the Liquor bath much more Room to rife and fall in, than the Pendulous Liquor in ordinary Glasses, where the Quantity of Air is much too fmall in respect of the Proportion of the Cavity into which it must expand it felf. when rarified; to make the rifing or falling of the Liquor in that, to be fo fensible enough. But belides, that this of ours bath this advantage, that the Quantity of Air is greater in respect of the Proportion of the Cylinder, and consequently the Water bath much more Room to play up and down in; it hath this advantage further that it is much more convenient for our purpose: Since the Ball of it may be immersed in Bodies, whose Coldness we have a mind to measure; and consistent Bodies, as Snow or Ice may be more conveniently heaped about it, than common Weather-glaffes.

Thirdly, Men too Confidently conclude, that if the Liquor in a Thermoscope rise an Inch higher to day, than it was the day before, and an Inch higher the next, that the Air must be as Cold again the last day as it was the preceeding; fince it appears not, tho' we should allow that Cold of it felf contracts the Air, That a

double

double degree of Cold must produce a double degree of Condensation exactly; for besides that the different Quantities of Air contained in these Instruments, and the Proportions of Pipes, as well as the degrees of the Expansions confidered together are sufficient to render the Hypothesis suspicious: I am inclined to believe. That the Condensation of the Air and the ascent of the Water depend on the Pressure of the ambient Air, as we shall in a little time make appear, and then this Computation will be found to be very fallacious : For we have elfewhere shewn that the forces required to compress Air, is in Reciprocal Proportions or thereabouts, to the spaces comprehending the same proportion of Air; so that if a Cylinder of four Inches be able to relift a Pressure equivalent to ten Pounds weight, when it comes to be compressed into two Inches; an equal force super-added to the former, will drive up that already compressed Air into half the space, which is about an Inch: Whence it follows. that in estimating the Condensation of the Air in a Weather-glass, we must not only Consider how much Space it is made to defert; but also what Proportion that deserted Space bears to the whole Space it posses'd before, and to what degree of Density it was brought before the Application of that force: And we must remember, that the refistance of the Included Air is not to be looked upon as that of a weight, which may remain always the same; but that of a Spring forcibly bent, whole relistance is greatest as it is crouded into less Room.

C 4 Fourthly,

The fourth Confidera-

Fourthly, we ought to have a regard to the particular Nature of the Liquors employed in Weather-glasses, till we have a more determinate Theory of the cause of Cold: For amongst Liquors, it does not follow, That because the one is most subject to be affected with the highest degrees of Cold, and to freeze; that the other is less susceptible of the lower degrees of it : Since it is observed, That Spirit of Wine receives notable Impressions from fainter degrees of Cold, than Water does, when made use of in Weather-glasses; tho' in our Climate the latter is much more readily turned into Ice. Befides, we are not to conclude, That all Subtil and most Spirituous Liquors must be least capable of being congealed; fince Oyl of Anisceds Distilled by a Limbeck, is extremely hot; yet will it be congealed by a much gentler degree of Cold than Water, and will be longer undiffolved upon a Thaw, And I know fome distilled Liquors, which confist of Parts very penetrating and vehemently Agitated; yet more Subject to freeze than the generality of Chymical Oyls or faline Spirits.

And indeed, if we allow, that Cold depends on a Diminution of the usual motion of the Parts of a Body; I see not, besides those more Catholick Agents which produce Cold in most Bodies they invade; why one Body may not be said to be more or less frigoristick in respect of this or that Body, and not of a third? For Q1 ck-silver will be coagulated by the sumes of Lead which have no such effect on other Bodies; nor can the atmost degree of Cold have the power to congeal it, and from what Afaramus

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the Jesuit relates it appears, That Water in peculiar Regions may receive fuch a disposition from the Soil, as to receive strange Impressions of Cold, in respect of the effects it produces there on Humane Bodies. And tho' Opium refrigerates not Water, as I have experienced by the help of a good Weather-glass; yet a few Grains of it presently refrigerate the Mass of Blood; which is not only an argument, That most Liquors have peculiar Textures; but that theParts of one Body may be so conveniently shaped as to be able, by infinuating into the Pores of another, to stop the Agitation of their Parts. And in favour of what we have laid down, I shall further add, That I know more Liquors than one, which, mingled with Spirit of Wine well dephelgmed, will presently deprive it of it's Fluidity; and the like change I have fometimes observed in other Liquors: And I can make a Liquor much of the same temper of Water, that receives a degree of Coldness by the Addition of a certain substance which stops the Agitation of it's Parts; that would scarce have any sensible effect on Water.

But to proceed to what we have further to Confideraoffer in favour of our new Thermometers, be-tions confides that the Water and Air may be both al cerning the ternately condensed, without the influence of mometers. the Atmosphere's gravity; they have another advantage. That they may be used in several Places, and removed without spilling the Liquor contained in them, or without danger of it being evaporated. Befides they may be fafely let down into any Liquor, even the most Corrolive; it we have a mind to examine their

Coldness

ness: In doing of which, instead of Liquors made use of in common Glasses, we employ Spirit of Wine tinged with Cochineele, opened by the most Volatile Spirit of Urine, which is not only in less danger of being froze, but susceptible of the flightest degrees of Cold impressed upon it by external Bodies. But tho' we think these Weather-glasses subject to fewer Exceptions than common ones; yet in estimating the feveral degrees of Cold, we look upon them as Instruments to be employed by our Reason, and not quite exempt from those Imperfections, we have imputed to Weather-glasses; fince I suspect, that fome fort of Steams, penetrateing the Pores of the Glasses, may have other effects upon the Spirit of Wine, than what they have in reference to Heat and Cold : For I once obferv'd, that having immerfed the Ball of a Weather-glass in a strange kind of a Luke-warm mixture, the Spirit rose up slowly 8 or o Inches in a Tube not above a foot long; and fublided not again much above half an Inch when exposed to the Air a good while after it had been immersed in Water & hours. Chymist Orthelius in his Theatrum Chymicum Vol. 6. tells us, That the Liquor Distilled from the Oar of Magnesia or Bismute, will swell considerably in the Glass it is kept in at the full Moon, and subside at the New; which observation the Jesuit Casatus makes use of as an Argument. And I have observed my self a Tincture of Amber made with rectified Spirit of Wine, undergoe feveral changes, when stopped up in a Bottle, which other Liquors abounding with Spirit of Wine did not; so that not unlikely,

if Weather-glasses furnished with different Liquors were kept together in the same Place, there would be some disparity, which could be ascribed to nothing but the peculiar Natures of the respective Liquors, which, tho' of different kinds, may receive the same Colour from the same Metals: So Copper gives the known Colour to Aqua fortis, and affords a fair Solution in Aqua Regis, as well as gives a lovely Blew to Spirit of Urine, or Sal Armoniac; and I have found, that it would give a good Tincture to

Chymical Oyl of Turpentine.

And to shew, that even Spirit of Wine in Weather-glasses may be worked upon and influenced by external Bodies, I shall add, That I have observed in one that lay by me some time, emergent Bubbles: Which whether they were only made up of united Bubbles lodged in the Pores of the Liquor, or some Parts of the Wine disposed to Elasticity by frequent alterations; I examin not: But sometimes they have been so great as to possess many Inches of space in the shank of the Weather-glass; which Bubbles, if they be small and lurk about the juncture of the Ball and of the Cylinder; may, by dividing the Spirit in the Stem from that in the Ball, hinder it from rifing according to the Changes of the Weather; a Bubble of Air being more dicffinltly removed up and down in the Stem of the Glass, than the Spirit it felf; in favour of which, we have else-where shewn, That Water will pass through a narrower space than Air, except the latter be forced.

But' to draw near to a conclusion, tho' I have mentioned all these difficulties about sealed Glasses I would not be thought to do it with a defign to fet Men upon greater Nicities than are necessary, but rather to excite us to take into our Confideration as many collateral Experiments and Observations; besides those made by our Sensories, on Natural as well as Factitions Bodies, in judging of the degrees of Cold as we can : For tho' Water be thought to be most susceptible of such an intense degree of Cold as destroys Fluidity, yet besides Oyl of Aniseeds. I have distill'd a substance from Benzoin, which becomes fluid and confiftent upon much flighter alterations as to Heat and Cold, than would freeze Water of thaw it: And I have observed likewise, That Amber-grease dissolv'd in highly rectified Spirit of Wine, or in other Sulphereous or Relinous Concretions dissolved in the same Liquor; will shoot into fine figured Masses in cold Weather, and re-diffolve in warm; others being more rudely congealed. And even in Chymical Preparations of Harts-horn and Urine, I have observed, That fometimes the Spirits would be clear, and at other times would fuffer a greater or less quantity of Salt to Chrystallize at the bottom; according to the various alterations of the Weather, in point of Heat or Cold.

But to bring Instances from more obvious Liquors, it is observed in some Parts of France by the Water-men, That their Boats will carry greater Loads in Winter than Summer; and on frozen Coasts in several Countries it is observed, That Ships draw less Water than on our British Coasts; which is an Argument, that the Water

is heavier and thicker in Winter than in Summer. And I my felf have poised a Bubble so exactly, with Water in it; that tho' it would fwim upon the top of the Water at Night; yet in the Day, when the Sun had rarified the Water it fwam in, it would subside to the bottom: And sometimes was so exactly of a correspondent weight with, and so equally poised in the Water, that it would neither subside nor swim upon the top, but move up and down till the Water was either more rarified or further condenfed.

From what hath been faid in this Chapter, it appears, If. That by reason of the various predispositions in Bodies, the testimony of our Senfes is not to be taken in judging of the feveral degrees of Cold. 2dly. Tho' Weather-glasses are subject to fewer alterations than our Senses, yet they may misinform us; except we, at the same time, measure the Air's Gravity by other Instruments. 3dly. Our sealed Weather-glasses are highly preferable before common ones. Athly, To conclude this Chapter I shall add, That I would not have Men eafily deterred from making Experiments about estimating Cold; because they may feem disagreeable to vulgar Notions, fince I doubt not but that the Theory we have is not only very imperfect, but ill grounded.

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CHAP.

CHAP. IV.

Concerning the cause of the Condensation of the Air, and ascent of Water by Cold in common Weather-glasses.

Concerning the Reason, why Water in common Weather-glasses descends upon Head and is raised by Cold? there are three Opinions

which may deferve our Consideration.

The Opinion of the Schools concerning the aftent of Water in Wather-glaffer examined.

The first is, that of the Schools and common Peripateticks, which teaches, That the external Air condensing that included in common Weather-glass; it rises to fill up that space deserted by the Air to prevent a Vacuum. But not to urge, That they have not yet proved, that Nature will not admit of a Vacuum, of that it is contrary to the Notion a Naturalist ought to have of Matter; to suppose it to act any thing contrary to its own natural tendency for a publick Good: I say not to urge these Arguments, which we have elsewhere made use of; I shall alledge the following Experiment. viz. That,

Rosperia ments alledged against their Doctrine. If a Bolt-head with a long Stem be made use of to try the Torrecellian Experiment with, the space deserted by the Mercury in the Cavity of the Bolt-head, and from whence the Mercury drove the Air, continues void; the Pendulous Cylinder remaining at 30 Inches, without offering to ascend to prevent a Vacuum. Nor will the Quick-filver rise 3 of an Inch higher upon the application of cold Bodies outwardly; tho in a common Thermometer, the same degree of Cold would make Water ascend several Inches.

To this I shall add another Argument taken Su Plate E from the consideration of sealed Weather-glasses Ng. 3. (see Plate z. Fig. 3.) in which it is observed. That the Air instead of contracting upon an increase of Cold, expands it self. If it be said, That the Water contracting the Air follows it to prevent a Vacuum; it may be demanded, Why. fince Nature causes the one to contract in common Glasses, and the other in sealed ones, to avoid a Vacuum; fhe does not rather make the Air retain its natural extension than suffer it to be condensed, and then put her self to double trouble, in compelling the Water to afcend contrary to its nature?

But not to infift on these Arguments, I shall rather urge, that what is offered by them will not folve the Difficulty; for whether the Water or Air be expanded into a large space, since Glass is impervious to Air and Water; I see not how a Vacuum interspersum and coacervatum can be avoided: For if upon the expansion, no other Body is added and penetrates the Glass to fill the space deserted by some Parts of the expanded Body, there must remain Vacuities betwixt them: Because it is impossible, the same quantity of Matter should compleatly and adequately fill a greater space by being expanded; the Parts of the Body being only able inadequately to fill it by receding from each other: But were it allowed, that upon the expansion of one of these Bodies, and the condensation of the other, a third Substance harboured in the space deferted by the one; it may be questioned, how fuch Matter should make its way out again?

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Mr. Hobbes bis Destrine examined.

The lecond Opinion I shall take notice of, is that of Mr. Hobbes, which is to me partly precarious, partly insufficient, and scarce intelligible; for tho' when he afferts, That the coldness of Liquors depends on their being pressed with a constant Wind, besides that he afferts it without Proof; it will appear from an Experiment shortly to be alledged, That Liquors sealed up in Glasses, and suspended in Liquors not subject to freeze, may be refrigerated; tho' it appears not how they can be raked on by the Wind as his

Hypothesis requires.

Secondly, I fee no necessity, that the Cold should press upon the superficies of the Water in the Shank; since by Cold it will be raised in a Weather-glasses, kept in a still Place and void of any sensible Wind. Besides, he ought to shew, Why Air insensibly moved deserves to be styled Wind, and how it is possible such a Wind should raise Water so many Inches by pressing upon it? Nay further, Water poured into a Bolt-head till it reaches into the Stem, will subside when refrigerated, and not rise. And if the Ball of a Weather-glass be encompassed with a mixture of Ice, or Snow and Salt; the Water will readily ascend; which how it will be explained by Mr. Hobber's Hypothesis, I do not see.

Thirdly, Mr. Hobbes allowing not of a Vacuum, I wonder he should tell us, That by a bare Pressure, the Water sinding no other Place to recede into, is forced to rise into the shank of the Weather-glass: For since, according to him, the shank of the Weather-glass must be full before; I see not how it should be able to receive the ascending Water, except to use Mr. Hobbes's

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own words, it can be fuller than full. Belides, it may be further alledged against Mr Hobbes his Doctrine, that it gives us no account of the condenfation of the Air by Cold, in Weather-glaffes in which the Water descends with Cold and

rifes with Heat.

Fourthly, whereas Mr. Hobbes in explaining the depression of Water in Weather-glasses, attributes it folely to it's own Gravity; it will eafily appear, that we must likewise have recourse to the spring of the included Air : For if a Thermometer be placed in the Sun, when the Water in the shank is but a little above the Surface of the Water without the Tube; the rarified Air will depress the Surface of the Water in the Pipe below the other, and sometimes so far, that some of the rarified Air making it's way out of the Pipe, as foon as the remaining Air is refrigerated again, the Water will be able to rife up higher into the Tube than it did before.

The third and last Opinion I shall consider is A Modern one held by some modern Naturalists, which opinion exascribes the Ascent of the Water to the Pressure of the Air gravitating upon the Surface of that Water without the Pipe; but supposes that the Air contained in it, is contracted by, Cold alone: As for the first Part of this Hypothesis, I readily Affent to it; but am apt to believe that and the Authe contraction of the included Air depends on poled. the same Cause, and that the spring of it being weakened by Cold, it is condenfed by the same Pressure of the Atmosphere; the weight of the External Air over-powering the weakened Spring of the Internal.

Fig. 5.

In favour of this Opinion I shall add the folsee Plate 1. lowing Experiments, and First, having filled a Vial capable of holding five or fix Ounces, half full (See Plate 1. Fig. 5.) and having inverted a Glass Tube into it, about 10 Inches long, much bigger than a Swan's Quill, it being firt fealed at one end and filled with Water; the Orifice of the Vial was closed with Cement, is that the External and Internal Air, had m communication with each other: It was placed in a Mixture of Snow and Salt, till the Water in the Bottom of the Vial began to freeze; ye notwithstanding so great a degree of refrigers tion, the Water in the Tube did not at all defcend; fo that either the Air was not conderfed by Cold, or the Water descended not to prevent a Vacuum. The Glass being left in this Posture, in our absence, the sealed end of the Pipe flew off; being beaten out by the la-

> tumescence of the freezing Water. Having fixed another Pipe as the former, which was fome Inches longer, and drawn ve ry sender at the sealed end, that it might eafly be broken; this was fet to freeze as the o ther, yet the Water descended not, but a foon as the top of the Glass-Tube was broke off, the external Air pressing upon the Water, and by the intercourse of that upon the Air; the Water in the Tube subsided 8 or to Inches, but rose again when the internal Air was ranfied, within half an Inch of the top; and the the Apex being sealed up it was placed in Snow and Salt, yet the Air in the top, had it's Spring fo weakened by refrigeration, that it was not able to depress the Water; tho' as soon as the

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Apex was broke off, it subsided several Inches,

the external Air preffing upon it.

The Experiment being a third time reiterated with 31 of Air in the Pipe, when the Water in the Vial was in some measure froze, it was able to expand it felf a little : But when the Apex was broke off, the External Air depressed the Surface of the Water two Inches, but being removed into a warm Room it afcended above an Inch higher than the uppermost Level.

Having put fo much Water into a Veffel, See Plate 1; (Such as Plate t. Fig. 6. Delineates) as was able to fill almost the whole Tube, we cansed a Mixture of Snow and Salt to be placed about the Ball of it, yet we perceived not the Water in the least to rise; but if at all, it might well be ascribed to the the Intumescence of some airy Parts lodged in the Pores of the Water. But the Apex of the Tube being broke off under Water, the External Air forced the Water feveral Inches up into the Cavity of the Pipe.

lowing Vessel (See Plate 1. Fig. 7) the Stem of Fig. 7. this being no thicker than a Raven's Quill tho' feveral Inches long, and the Ball being about as big as a Nutmeg; we dropped a few drops of Water into the Stem which being suspended there, betrayed very flight changes in the Rarefaction or Condensation of the internal Air. Watching therefore when the Air within had raised the Bubble up to the top of the Stem; we

immediately sealed it up, and observed, That tho' the fealed Glass was placed in a Mixture of

Another Experiment we made with the fol- See Plate 1.

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Snow and Salt, the Bubble did not in the les fublide: But if the Apex of the Stem was broke off, the Bubble of Water would be formetime depressed so low, as to fall into the Ball of the Weather-glass. And what was further remarkable was. That when the Liquor was descending if the end of the Tube was sealed up; the Water would immediately stop at the place it refted at, when the Pressure of the Atmosphere was taken off: Where it would continue till the Stem was broke open again, and then the Water would be further depressed; as the weight of the Atmosphere was able to over-power the Relistance made by the internal Air.

Fig. 7.

Having made use of such a Vessel (as Fig. 7. See Plate 1. Plate 1.) represents and conveyed a pretty Quantity of Water into both the Legs, we fealed up the end of the bent Stem; leaving fo much Air above it as we thought convenient: Which being done, we placed the Ball of it in a frame, in which, the Tube hanging down, we could cover the round Ball with Snow and Salt: Upon which the Air in the Stem was able to expand it felf so far, that the Water in the longer Leg was raised the length of a Barly-corn higher than before, and depressed as much in the other: But when the end of the Stem was broke open, the Water was raised 21 Inches in the longer Leg, and depressed so low in the shorter, that several Bubbles rose into the Cavity of the Ball.

In which Experiment it cannot be supposed, That the weight of the Water in the shorter Leg could be able, to raise the Water in the other, except by Virtue of it's Spring, which being



but small, answerable to the Quantity of of it; it cannot be expected that it should have any confiderable Effect upon the Air in the other Leg; tho it's Spring were in some measure weakened by Cold.

An Explication of the Figures in the first Plate.

Fig. 1. p. 12.

A. The Ball or Egg.

B.C. The Stem.

D. The little Aqueous Cylinder.

Fig. 2. The open Weather-glass mentioned p. 16, 22.

Fig. 3. The Sealed Weather-glass, or Ther-

moscope mentioned p. 16.

Fig. 4. The Barometer or Mercurial Standard placed in a Frame B B. mentioned p. 17.

Fig. 5. An Instrument mentioned p. 34.

A. The Vial.

B C. The Pipe cemented into the neck of the Vial, open at C and fealed at B.

Fig. 6, p. 35.

A. The Bolt-head.

B. The small Stem.

BC. The Cylinder of Water enclosed.

Fig. 7. p.36.

CHAP. V.

The Experimental History of Cold begun,

TITLE I.

Experiments concerning Bodies capable of Freezing others.

D Efore we proceed to the natural History of Cold, it perhaps may be necessary to consider what Bodies are capable of retaining fuch Qualities, and what are not; but that being a confideration not fo necessary to our present purpose, which is only to set down what Observations we have made in Bodies subject to be froze; I shall only in short take notice, That most Bodies, except fire, are susceptible of actual Cold, and it is a Question whether even that be not rather a state of Matter in such a peculiar motion, than a distinct and particular species of Natural Bodies; since even Gun-powder, and Spirit of Wine before they are fet on fire by some other Body are actually Cold. But to proceed to what Observations relate to our Title.

Experiments of Bodies capable of freezing others. 1. Bodies cold enough to freeze others are very few here in England; Snow and Salt mixed being most remarkable; which cool the Liquor contained in those Vessels, which are closed up in such mixtures.

2. Snow



2. Snow alone would not freeze Water, as a Mixture of it and Salt does; and tho' Water poured betwixt the Interstices of Snow or Ice freezes; yet there is a great disparity, betwixt exposing it to the Air, and keeping it up in Vessels; and tho' it is froze, when covered with Snow in a Bottle all night, yet that may proceed from the Coldness of the Air, as well as the insuperce of the Snow.

3. If Nitre, Allum, Vitriol, Sal-Armoniack, or Sugar be mixed in due Proportion with Snow; they will enable it to freeze, tho' not so intense-

ly as common Salt.

4. Spirit of Salt being shaken together with Snow in the Vials, they caused a Dew which was gathered on the outside the Glass to be froze; tho' the Mixture within was not, and Oyl of Vitriol mixed with Snow in a thin Vial, had the same Effect only more intensely.

5. But not only these Acid Spirits had these Effects on the moisture of the Air condensed on the outside the Glasses; but likewise Spirit of Nitre, Spirit of Vinegar, and Spirit of Sugar, the former of these three being very powerfull, tho' the latter were not so strongly frigorisick.

6. Spirit of Urine mixed with Snow in a Vial froze the External moisture weakly; but Spirit of Sal-Armoniack drawn from Quicklime did it powerfully.

7. Spirit of Urine and Oyl of Vitriol poured

upon Snow, froze moderately.

8. Sal Gem, with a fublimate made with common sublimate and Sal-Armoniack; nay, and with both loaf and Kitchin-Sugar; as likewise a strong solution of Pot-ashes mixed with D 4. Snow

Snow did freeze, tho' very faintly. And both a Solution of Salt of Tartar and Pot-ashes Agitated with Snow in a small Vial, produced Filmes of Ice on the outfide the Glass, tho' very thin ones.

9. A sweet Solution of Minium in Spirit of Vinegar mixed with Snow, excited the frigorifick Quality of it; yet some of that Solution being enclosed in Snow and Salt, would not be froze by them. Snow shut up alone, thawed much more flowly, than that which was mixed with Salts or Spirits. No Salts will promote the frigorifick Quality of Snow, so far as to enable it to freeze, which quicken not it's Difsolution. Neither Chrystals of Tartar, nor Borax, both beaten to powder, nor Sublimate would enable Snow to freeze, as well as the Powder of each lying undislolved in it.

10. Water of Quick-lime being twice tryed would not freeze, but only gather a dew on the outside; yet the Liquor being kept up 1 2 Months the Spirits with which those Waters abound

flew away.

11. Oyl of Turpentine in which Ice dissolves flower than in feveral other Liquors enables not Snow to freeze. Tho' Spirit of Wine shut up with Snow in a Bottle, enabled it to freeze powerfully, and to Chrystalize even Urine it felf, which might be taken off in Scales.

12. Spirit of Nitre and Snow being mixed together in a just Proportion froze very powerfully and speedily, not only Water but Spirit of Vinegar, and weak Spirit of Salt; the first of which retained it's tafte, when froze, and the latter shot into Chrystals which lay across

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each other. A Solution of Sal-Armoniack partly evaporated would shoot into Chrystals like combs and feathers, and Sal-Armoniack distill'd from Quick-lime would shoot into Branches almost like those, so nimbly, that one's Eye might discern them to spread and increase. The like Experiments being tryed with Wine and strong Ale succeeded, but very faintly.

13. Since Bodies generally help Snow to freeze, which hasten it's dissolution; we threw into a Vial, which contained Snow, heated Sand, which enabled it to cause a Dew, but not to freeze. And warm Water poured into another, when it had been shaken, produced a considerable degree of Cold, and gathered Dew,

but froze it not.

14 Tho' it is generally believed, That the Hoar-froast on Glass-windows, is only exsudations through the Pores of the Glass, and froze by the External Cold; yet it will easily appear, That it is rather on the inside the Glass; the Steams which rove up and down the Room being condensed by the External Cold, and froze.

the outside of the Vialin the fore-going Experiments, proceeds not from any subtil Parts of the Mixture penetrating the Pores of the Glass and settling on the outside; we found that four Ounces and 1 of the Mixture of Ice and Salt, being shut up in a Vial, by the access of Dew on the outside, the weight of it was increased 12 Grains. Another Vial which contained two Ounces six Drams and a half increased in weight 4 Grains; the Vial being unsealed under Water,

it fucked in a good quantity of it, Six ounces of Snow and Salt being fealed up in a Glass, the Hoar-Frost was wiped off but returned again: and the Vial being counterpoised in a pair of Scales, the Vapours condensed by the coldness of it, in the time that the Snow was melting. weighed 10 Grains. A like quantity of Snow and Spirit of Wine being flut up in a fingle Vial, the outside was presently cover'd with Ice. and in all it became 7 Grains heavier than be-Another time a mixture of Snow and Salt, which weighed 31 ounces, afforded 18 grains of condensed Vapours. And a mixture of Snow and Sal-Gem. which counterpoised 2 onnces and 70 grains, upon an additional weight of condensed Vapours, weighed 20 grains more than before.

TITLE II.

Experiments and Observations concerning Bodies disposed to be Frozen.

Of Bodies disposed to be frozen.

ting, that there are several Bodies disposed to be froze by one degree of Cold, that are not with another; I shall observe,

1. That in very cold fnowy Weather, Water, Urine, Beer, Ale, Milk, Vinegar, French and Rhenish Wine, were either totally or partly turned into Ice. But besides these more obvious Instances, we froze a Solution of Sugar, and another of Gum Arabick, in Water; a Solution



lution of Allum, Nitre, and Vinegar, froze without affording any confiderable Phænomens. A Solution of Vitriol was in part froze, and in part unfroze, that which was froze being not much different in colour from Water; but the unfroze part was of a very high Vitriol-colour.

2. Spirit of Urine and Spirit of Vinegar expofed to an intense Fire, both of them froze.

3. A drachm of Salt of Pot-ashes being disfolv'd in two ounces of Water, presently froze in an intense Cold; and Oyl of Tartar per deliquium, or at least, a Solution of the fixed Salt of Tartar was congeal'd in a mixture of Snow and Salt.

Appendix to the II. Title.

Oyl becomes much more hard in Muscovy than here in England in the most excessive Cold, but will in neither be turn'd into perfect Ice. And Captain James, speaking of an Island where he and his Men were forced to Winter, Pag. 58, says, All our Sack, Vinegar, Oyl, and every Thing else that was liquid, was now frozen as hard as a piece of Wood, and we must cut it with a Hatchet. And Olaus Magnus, Gent. Sept. Hist. 1. 11. C. 24, says, speaking of the Fights wont-to be made on the Ice in the Northern Regions, Glacialis congressus sit in Laneis calcibus, non pellibus, aut coris unstis. Vis enim frigoris, quod-cunque sit unctuosum, convertit in Lubricitatem glacialem.

There being a great similitude betwixt Spirit of Wine and Oyl, in respect of their inflammability,

bility, and being dispos'd to mix with oily Bodies, and as great an aptitude in the Spirit of Wine to mix with other Liquors: I enquir'd of the Russian Emperor's Physician, what alterations he had observ'd to be produc'd by Cold in Muscowy? To which he answer'd, That Ansseed and other weak Spirits would be turned into an imperfect kind of Ice, and that strong one would turn Ice into a kind of Substance like Oyl.

Particulars referrable to the II. Title.

1, In a very hard Frost in December, a Solution of Minium near the Fire seem'd to be froze; tho' it was made with Spirit of Vinegar, and so strong, that part of it was shot into Saccbarum Saturni. Some at the top, which was yellow, did not freeze, tho' poured out.

2. A Solution of Gold made with Salts was likewise froze. As also a Pint-vial full of the Tincture of Lignum Nephriticum, which being froze, the Ice had no such colour as the Tin-

cture.

3. It is reported, That in Russia, Brandy will freeze, but the Ice of it is not so hard as common Ice. And I am informed, that in Moscow the Spirit of Wine would freeze; leaving some dissolved in the middle which was much stronger than ordinary Brandy. And I am told, that in Russia it is usual to have Wine froze.

French Brandy being exposed to the Air in Russia froze; and Sallet oyl become as hard as Tallow, but Water, at the same time did not

frecze.

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TITLE III.

Experiments touching Bodies indisposed to be frozen.

THE fubtil parts of feveral Bodies be- Bodies not ing brought over by distillation, would disposed to not freeze by fuch an application of Snow and Salt as froze other Bodies. Of this fort were Aqua-fortis, Spirit of Nitre, of Salt, Oyl of Turpentine, and almost all the Chymical Oyls we had then in possession; Spirit of Wine, and of other fermented Liquors; and Sack, if good, would scarce freeze; but the inflammable Part being spent by burning, it would easily freeze.

2. Two drachms of Salt of Pot-ashes, being dissolv'd in an ounce of Water, the mixture would not freeze; tho' the outlide of the Veffel was cover'd with Ice. At another time a ftrong Solution of Salt of Tartar would not freeze, tho' at the fame time Salt of Pot-ashes

being dissolv'd did.

3. That common expressed Oyls of Vegetables will freeze after their manner, and curdle in cold Weather, is commonly observed; yet Train-oyl, which is usually made of the Fat of Whales by the help of Fire, continued fluid in Weather that was very fharp, but in an exceffive cold night it lost its fluidity; which seems to disfavour what Olaus Magnus writes, who fays, That in the Northern Regions it is usual to cast Train-oyl upon the Water in their

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Ditches, to keep the Water from freezing, and thereby unpassable, the Oyl, as he says, not being subject to congele with Cold; but it may be worth while to enquire, Whether the Train-Oyl he speaks of be the same as is used by the Swedes, Laplanders, and Muscovites, and whether they have a different way in keeping of it or not?

4. Tho' a Solution of Sugar would freeze, yet a strong Solution of Sugar of Lead would not in a mixture of Snow and Salt; which is remarkable, since the Spirit of Vinegar it self would freeze: Besides there must needs be some Water in the Solution, and the Sugar being but a Vitriol of Lead, it is not a little strange, that it should not freeze as well as common Vitriol; tho' in this latter concrete, Metal be corroded by a Spirit; which, if we may judge by the Liquor afforded in Distillation, is very much sharper and stronger than Spirit of Vinegar.

5. Quick-filver would not freeze in the sharpest Air, tho' expos'd to it in very thin Glasses, and in such a manner, that a little quantity of

it made a large Surface.

6. A very sharp Frost was not able to freeze a strong Brine, tho at the same time other saline Solutions were congeal'd. But a Solution consisting of twenty Parts of Water and one of Salt, was froze in a very sharp Night; the Ice swimming at the top, in Figures almost like Broom, spreading from the surface of the Water downwards: The Salt dislov'd in this Water, is double the proportion of that which is usually in Sea-water. I thawed Ice of Salt-wa-

ter, to try whether the dissolved Ice would be fresh or not, but it retain'd a little brackishness, which, I suppose, it receiv'd from the contiguous Brine; tho' I am inform'd, That in Amsterdam they make use of thaw'd Ice, instead of common fresh Water, in Brewing. And Bartbolinus de usu Nivis, Cap. 6. p. 42. says, De Glacie ex marina aqua certum est, si resolvatur, salsum saporem deposuisse, quod etiam non ità pridem expertus est Cl. Jacobus Finchius Academia. Nostra Senior, & Physices Professor, benemeritus, in Glaciei frustis è portu nostro allatis.

Particulars referrable to the III Title.

t. Spirit of Sal-Armoniack made with Quicklime, volatile Oyl of Amber, a small quantity of Oyl of Vitriol, being exposed two Nights and a Day, stoze not. A Solution of Silver in Aqua fortis was; and Spr. Sanguinis Humani, being froze, swelled so much as to force out the Cork.

2. Unrectify'd Oyl of Turpentine exposed to the Cold in a Bottle would not freeze; but another Portion being contain'd in an earthen Por-

ringer did.

3. I am inform'd, That there is a Lake of Water in Scotland, out of which a small River runs, the Water of both which is never froze;

but dissolves Snow or Ice if cast into it.

4. Sallet-oyl being made use of to keep the Locks of Guns from freezing, hinder'd them from being discharg'd; but Oyl of Hemp, or Train-oyl kept them from freezing.

TITLE IV.

Experiments and Observations concerning the degrees of Cold in several Bodies.

Of the degrees of Cold in Several Bodies.

To discover the different degrees of Cold we have proposed several Thermometers in the preceeding Chapters, concerning which we shall add this Advertisement viz. That the those which are to be immersed in Liquors, have the Ball end round; yet, when we are to try the degrees of Cold of consistent Powders, it is better to make use of such as have shall bottoms, that they may be able to stand on their own Bass: For so it will be pleasant to see the suspended Bubble in one of our Thermometers rise and fall, as it is removed from one Body to another.

2. Freezing hath been so generally esteemed, the utmost Essect of Cold, That most have been content, without examining strictly the several degrees of it. Nor indeed is it very easily done, since if we do it with common Weather-glasses it will be a hard thing to distinguish whether the Cold of one Day, exceeds that of another; since there intervening so much time betwixt the Observations, the Alterations may be caused by an increase in the weight of the Atmosphere. And should we make an estimate by the Testimony of our Senses, we should easily be mistaken; since it is believed, That the different sensations of Cold which we perceive, depend on the various Dispositions of our Bodies.

But



But allowing that volgar Thermometers might give us a true information of the degrees of Cold which Nature affords, yet they acquaint us not whether Art may not produce greater; much less will they help us to make an estimate of this Disparity. And though we may make some guess by the Operation of Cold on Liquors exposed to it, yet some as Aqueons Liquors freeze too foon, and vinous Liquors here in England will not freeze at all, except French Wine; which happens feldom and leaves too great an Interval betwixt the degrees necessary to congeal Wine, and sufficient to freeze Water, belides the uncertainty proceeding from the feveral strengths of Wines.

Wherefore to discover the Intensity of Cold. produced by Art above the highest degree that See Plate. Nature affords, we furnished a sealed Weatherglass (Such as Plate 1. Fig. 1. Delineates) with Spirit of Wine, and immerfed the Ball and part of the Stem in a Vellet of Water, which was half buried in Snow and Salt, and when the Water began to freeze at the bottom and-about the fides, the Liquor was Subfided to 5 Divisions, each Division being half an Inch; and then the Weather-glass being taken out of the Water and applied to the Snow and Salt, it

Sublided to 13 Division.

To this we shall add another which shews, That the Water tho' froze was warmer than the Spirit of Wine, when the Mixture of Snow and Salt was applied to it. Jan. 19 the Weather-glass being kept in the Water till it began to freeze descended to 51 but being removed nto the Snow and Salt it Sublided first briskly

and then more gradually till it fink to the Bottom of the Stem; but being removed into the Water again, it accended to the fame heigh, the Water had before depressed it to.

For a further Tryal, how much Liquors my be condensed by Cold, we took Oyl of Turpentine rectified in a gentle Heat, and having weighed a Glass-ball with a long Stem, it being one Ounce, one Dram, five Grains and a half; we poured on it fo much of the Turpentine as in creased the weight to two Ounces seven Drams and thirty four Grains and a half; which reaching a little way into the Stom, we marked the Superficies with a Diamond; after which we poured a Dram more in, and fuccessively more ftill marking how high each Parcel, which was weighed exactly, rought in the Stem, till the Additional weight increased the former to three Ounces, one Dram, four Grains, and half; and then taking a wide-mouth'd Glas with Water in it, we immerged the Weatherglass in the Water as before; the Vessel in which it was contain'd being first encompass'd with Snow and Salt: When the Water began to freeze we mark'd the Stem of the Glass which contain the Oyl at the place to which it subsided; then conveying it into a Mixture of Snow Salt, when it had subsided as low as it could, we mark'd the Superficies, and then remove it into the Air, till it rose to it's first station; and then we pour'd fo much of the Oyl out intonother Glass carefully poised in a pair of Scales, that the Superficies of the Oyl remain'd at the Mark which it subfided to in the Water; and we found that the Oyl poured off weigh'd > bout



bout 10 Grains: And fo much more being pour'd off as made it stand at the Mark to which the Snow and Salt depress'd it, it weigh'd about as much as the former ; fo that the Oyl was Artificially condensed, so far, That it subsided as much after it had been condensed by Cold ftrong enough to freeze Water, as it was caufed to fall by the force of that. And by dividing the whole Proportion of Oyl, by the number of Grains whose Bulk it feem'd to lose by subsiding in Water, we found that it was condensed by the first degree of Cold to a 94th Part of it's Bulk and by dividing it by the Additional number of ten Grains more, we found that the Snow and Salt had condensed it a 47th Part of it's Bulk.

Having circumscrib'd Water moderately Cold with a Mixture of Snow and Salt, what it shrunk was, if not insensible, inconsidera-

ble:

To measure the differing weight and Density of the same Proportion of Water, in the Heat of Summer and when extremely Cold; we weighed a Glass-Bubble in it, which was Heavier than Water moderately cool, and by the Diminution of it's weight in that Medium; we found, according to the Rules of Hydrostaticks, the weight of a Portion of Water of equal Bulk : And then weighing it in Water cool'd, by a Mixture of Snow and Salt, we were inform'd by a new Decrement of it's weight, of the weight of an equal Bulk of that Cold Water; by which we were enabl'd to make an Estimate of the Gravity and Density acquired by the Action of Gold, and by weighing the same Bubble in the fame

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fame Water in hot Weather, we Learnt further how much more dense and heavy Water mode. rately Cold and extremely Cold, is than warm Water. It would be of use to try such Expenments as these in Italy, where they have the Conveniency of keeping Snow, and of freezing warm Water speedily. A Glass-Bubble which in the Air, weighed iso Grains being weighed in Water; on a Day not frosty, it weighed 294 and being weighed in Water which wa a little froze in a Mixture of Snow and Ice, it was not above & Part of a Grain lighter than before; fo that the Water by Condensation los not above a 230th Part of it's former Bulk How far it may be of use at Sea to make such Experiments as thefe, and whether they may thereby learn to know, by finding the Density of the Water in several Places; what Loads to carry in their ships and what the Water will be able to bear, I shall leave others to Judge: But if fuch Experiments be try'd in feveral Parts; our Seal'd Weather-glasses, or that which contains the Pendulous drop of Water, may be of use; fince they not being subject to be varied by the Alterations in the Atmosphere's Gravity, and fince they may be conveniently carried from one Country to another, the different degrees of Cold in various Regions may be better Estimated; a Register being kept of the degrees the Liquor or Pendulous drop stood & fuch times as the Tryals were made and where, and when exposed to such a degree as was ! ble to freeze. To conclude this Title I shall add, that in making these Experiments, with the Thermometer



mometer in which the Pendulous Water is contain'd; the Stem may, for conveniency, be held either Horizontal, upwards or Perpendicular.

TITLE V.

Experiments concerning the Tendency of Cold upwards or downwards.

THAT Heat generally acts most power- What way erfully on Bodies above it, and that it's in what Tendency is upwards, is self-evident: But to ass. most discover in what Line Cold acts most vigorous- vigorously. ly and furthest, we made the following Experi-

ments.

A Glass-Bubble with Water in it, having a flat Bottom, was suspended within less than half an Inch over a Mixture of Ice and Salt, but froze not. A Bottle which contain'd a Mixture of Snow and Salt being held under Water, it was cased with Ice, especially about the Bottom; so that the Action of Cold seems chiefly

to tend downwards.

But I rely less upon this Experiment, because it is observed, That when a frigoristick Mixture is exposed in a Vial, the Ice on the outside is always opposite to the Mixture, not reaching higher or lower than that Mixture, above half the Breadth of a Barly-corn; and as the Mixture dissolves, and that which swims upon the dissolved Part grows less and less, so Proportionably the circle of Ice grows narrower on the outside, till the Mixture is wholly dissolved, and then the Ice vanishes.

And

And from an experiment faortly to be medtion'd, viz. Eggs suspended under Water, it appears, That Cold acts on every side, the Shells

being wholly incrustated with Ice.

To put an end to this Title, I shall, in order to facilitate some Experiments hereafter to be made, advertise, That whereas in common Erperiments Water naturally beginning to freeze at the top, and that Ice confining the subjacent Water, so that when froze it hath not room to expand; I fay, whereas in such cases the Glass are subject to break, to prevent such ill Confquences; I lay the frigorifick Mixture first about the bottom of the Glasses, by which means the Water beginning to freeze at the bottom, the Water is raifed up above it; and as the Salt and Ice is raised higher about the Glass, so the lee gradually rifes, without danger of breaking the Bottles. To this Advertisement I shall add, That tho' I only at the first lay the mixture about the bottom of the Glass, yet to keep the Water above, cool, I usually put Ice it self or Snow (ather of which will succeed in these Experiments) above that Mixture.

TITLE

TITLE VI.

Experiments and Observations concerning the preservation and destruction of (Eggs, Apples, and other) Bodies by Cold.

IT is a common Tradition, That if Eggs or of the Pre-Apples be thawed near the Fire, it spoils fervational them; but if they be immersed in cold Water, Badies by they thaw slowly without dammage. To try the truth of this Tradition, I made the following

Experiments.

An Egg which weighed 12 drachms and a grain, being wrapt in a wax'd Paper to defend it from the thawing Snow, was froze in a mixture of Snow and Salt; and then wanting 4 grains of its former weight, it was put into a Basin of Water: It acquir'd such a Crust of Ice about it, as increased the weight to 15 drachms and 9 grains; and the Ice being taken off, and the Egg dryed, it weighed 12 drachms and 12 grains; being broke we found it almost thawed: When froze it swam in the Water, but when thawed it sunk.

We took two Eggs well froze, and placing them both at an equal distance from the Fire, the one was put into Water and the other laid on a Table: When that in the Water was crusted over with Ice, we took it out, and breaking it, found that the Yolk and some part of the White were thawed; but the other Egg being cut as funder, the White was wholly frozen, and the Yolk hard as if it had been over-boyl'd: There likewise appear'd in it certain concentri-

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cal Circles of different Colours, and a very

white Speck in the middle of it.

The same Experiment being tryed a second time, we were confirmed in our Perswason, That frozen Eggs will than sooner in cold Water, than in the open Air.

An Egg being suspended in Water, was cover'd with a Crust of Ice equally thick on all

and the lofides.

Frozen Pippins being put into a Basin of Water, were covered over with a Crust of Ice of a considerable thickness; where it was observable, r. That that Part of the Pippin which was immersed, was covered with a much thicker Crust than that which was above it. 2. The extant Part seem'd harder than the immersed.

3. Those in the Water were thawed, but one that lay out of it was much harder and more froze.

4. Neither the frozen Eggs or Apples condensed and froze the Air, tho' they incrustated the Water.

Eggs being froze in Snow and Salt till they crack'd, we put one into Milk, two into a Glass of Beer, and two more into a large Glass of Sack, but produced no Ice. Eggs being put into Vinegar produced no Ice; but the Vinegar cor-

roded the Egg-shells.

A Cheefe immerfed in Water in a cold Country, was crusted over with Ice; but lumps of Iron, pieces of Glass, and Stones, being kept longer in Snow and Salt than was sufficient to freeze Eggs, produced no Ice in Water.

Water being poured into a Bottle which stood on the North-East side of our Elaborotory, Part

of it was presently turned into Ice.

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Ice and Juice of Pippins shaken together in a Vial produced a great deal of Dew, and so did ke beaten into a Liquor with the White of an Egg. Pippins were much better when thaw'd

in cold Water than hastily.

It hath been observed in the cold Northern Climates, That when they have come out of extreme Cold too hastily to the Fire, it hath raised Blisters; wherefore it is a custom amongst the more careful fort, to wash their Hands, or other frozen Parts, in cold Water or Snow before they approach the Fire. I am told by one, That Cheeses being froze in Muscory, those thaw'd in Water were crusted over with Ice; but were much better than others thaw'd in a Stove. And Guilielmus Fabritius Hildanus, Cap. 10. de Gangrana & sphacelo, gives an Account of a Man who was successfully thaw'd and crusted over with Ice as our Apples and Eggs were.

Tho a moderate degree of Cold preserves Bodies from putrifaction; yet Glaciation leaves them more subject to it upon a thaw, tho while

they are in that flate they putrifie not.

To prove that the highest degree of Cold under Glaciation hinders Bodies from Corruption, I shall alledge the following Instances, Bartholinus de usu nivis, says, p. 80. Regis Mutinenses nivem boc fine arcte compassiam servant, in Cellis, Nivarist, in quibus servente estate vidi carnes massatorum Animalium a Putredine diu se conservasse. And Capt. James in his Journal, p. 74. hath these words, By the nimth of May we were come to and got up our five Barrels of Beef and Pork, and had four Buts of Beer and one of Cider—It had lain under Water all the Winter; yet we

could

could not perceive that it was any thing the worfe.

P. 79. he farther fays, That a Cable having lain under Ice all Winter, was not in June found a

jot the morfe.

And from Simlerus his Account of the Aps, it appears, That entire Bodies may be preserved by Snow without Glaciation. Refert (says Bartholinus, speaking of him, p. 79. de figurativis) in Rhetis apud Rinmaldios; nivium è monte ruentium moles Sylvam er procesas Abietes dejecisse, accidisse etiam Helvetio Milite per Alpes iter faciente, ut 60 homines er plures eadem Nivis conglobatione opprimerentus. Hoc igitur Nivium tumulo sepulti ad Tempus, astatis delitescunt, quo soluto nonnibil Nive decidus Corpora Mortua inviolata patent; si ab amieis vel transcentibus quarantur. Vidimus ipsi triste hoc Speciaculum, &c.

To prove that inanimate Bodies whill froze are not subject to Pusrisaction, I shall bring several Instances. Nor indeed is it much wonder, since, whether Glaciation proceeds from intruding Swarms of frigorisck Atoms, wedged in betwixt the Parts of a Body, or whether we suppose it to arise from an avolition of those restless Particles which before kept the Body shud or soft; we must suppose an unusual rest, and confequently the concomitant cause of Corruption

to be wanting.

But to proceed to Instances, I am told, That on the Coast of Sweeden and Denmark, the Cold will preserve Bodies a long time from putrifaction. And Bartholinus relates a Story of several dead Bodies (p. 83. de usu Nivis) which being killed in a Battel in the Winter, were froze in several Postures, and continued so without be-

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ing corrupted as long as the Winter lasted. To which I shall add, that Capt. James tells us, p. 76. of a Man whom they found froze in the Ice six Weeks after he had been committed to Sea, and all the alteration the Frost had wrought on his Body, was, that his Flesh would move up and down upon his Bones like a Glove upon a Man's Hand. And Bartbolinus de usu Nivis, Cap. 12. further tells us, That 'tis observed in Greenland, that the Frost preserves Bodies from

Putrifaction 30 Years.

But tho' freezing preserves Bodies from Putrifaction for the time, yet when they thaw they presently discover, that the Textures of them were impaired and vitiated all that while by the action of the Cold; for having froze an Ox-Eye, I observ'd, that the Chrystalline humour, which was so transparent before, being froze, lost its diaphaneity and became white. And it hath been observed by others, That tho' Cheeses which were thaw'd in Water, were better than those that were otherwise freed from the Ice; yet they were all, in some measure, impaired by the Frost.

To these Instances I shall add, that Purchas, Lib. 3. Cap. 5. Sect. 2 p. 493. tells us, That in Nova Zembla, their strong Beer being froze, was whosly vitiated, and without strength or taste. And Capt. James tells us, That strong Alicant Wine, by being froze, had lost much of its Spirits. And it hath been observed in the Northern Country, less cold than Muscovy, That Beef having been froze, was almost insipid, and yielded Broth little better than Water. Besides which Instances I am inform'd, That

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Bodies much harder than any yet mention'd may be work'd upon by Cold; not to mention, that it is observ'd, That Bones, and even Steel it self, are much more subject to break in frosty Weather than at other times. And it is to our present Purpose, further observable, That Capt. James resates, that in Charlton-Island the Wood must be thaw'd before the Carpenters are able to work it.

And I am further inform'd, That the Timber of the Houses in Moscow will not only crack in frofty Weather; but 'tis observ'd, That Brick-Honfes in the West-Indies decay much sooner than here in England. And it hath been further observed. That Marbles themselves have not only flown in pieces in frosty Weather, but that Brafs-Instruments, and even Iron-Hoops have been crack'd by extreme Cold; as Olans Wormius, and the Dutch-men in their Voyage to Nova Zembla witness. But I am apt to believe, that the breaking of the Iron-Hoops rather depended on the operation of the Cold on the Liquor contain'd in those Barrels; than immediately on the Iron-Bars themselves, and that they were broke by the expansion of that Liquor.

An Appendix to the VI. Title.

In confirmation of what hath been deliver'd before, the Russian Emperor's Physician told me, That if those that have their Noses or Cheeks froze, don't rub them with Snow before they go into the Stoves, they sometimes drop off; and he likewise told me, That moderately weak Wine by being froze, would lose both its colour

lour, and tafte. He further told me, That Bodies there, will keep all the frosty Weather uncorrupt; and that Venison and Beef, and other Flesh, will be preserved a long time by Frost; but if it is not thawed leasurely before it comes to be roasted, it will be much impaired. And Iam told, That a young Man having been froze all over, was recovered by being first rubb'd with Snow before any other means was used.

Particulars referrable to the VI Title.

Fishes taken from under the Ice, in Lakes and Ponds which were frozen over, and packed up, would be preserved a Month without being salted or dryed; and it was observed. That when they were taken out of the Water in the cold Air, they would be froze immediately. It was likewise observed by the same Person who told me these things, That tho' Flesh-meat froze was better when thaw'd leasurely in cold Water than hastily by the Fire, yet it acquir'd not a Crust of Ice about it.

In Lapland when any Part is froze, they toalt Cheese made of Deer's Milk, and anoint the affected Part with the Cows-boby.

I had some Cheshire-Cheeses froze my self, one of which being thrown into Water gather'd a Crust of Ice about it.

There are white Bears in Green-Land which have so excellent a scent, that when the Carcass of a Whale was left at some distance from the shore; they would raise themselves, on their Legs, and with their two Paws, would fan themselves with the Air, and snuffit in at their Snouts

Snouts, and then throwing themselves into the Sea would Swim towards the dead Carcaffes: the fat of some of them would yield a Hoghead of Oyl. In Moscow a Hogshead of Malaga-Sack being froze, a Spirituous Liquor distill'd out of it ftronger than the Sack it felf; but the Liquor left behind it, was a strengthless Phlegmi A Barrel of Beer being froze on the Coast of Green-Land, the Spirituous Part was contain'd in the middle.

The Spanish and French Wines, that are brought to Moscow betwixt Russia and Poland, are sometimes so frozen by the time they come there; that they are forced to break the Casks. and to transport it in Jars from one place to another, and when they have a mind to thaw it, they put it into another Hogshead, and that being placed in a hole made in Ice or Snow, it thaws leafurely there without being fo much impaired as if thawed in a Stove or by the Fire.

TITLE VII.

Experiments concerning the Expansion of Water, and Aqueous Liquors by freezing.

Of the Ex- .

T HO' it hath been generally allowed, that Water and other Liquors are condensed be freeze by Cold; yet from what I shall offer, it will appear, That Ice is not Water condensed but Rarified.

> For I have not only observ'd, That Water exposed to be froze in a Bolt-head, would if the filgorifick Mixture inclin'd it to begin to

trecze

freeze at the Bottom first, be expanded, so as to rife confiderably higher in the Stem, but when that Ice was thawed again will fublide. And to this I shall add, That having included Water in a Orlinder, both ends of which were stopped up withWax, the Cylinder being hung up inthe Air, and the Water froze; it was fo far expanded, That it forced the Wax out of each end of the Pipe, and form'd a Rod of Ice much longer than the Cylinder; from whence it appears, That the breaking of Bottles by Cold rather depends on the Expansion of the Included Liquor, than that the weight of the Air caused that Effect, as some Moderns teach; or that the Internal Liquor being condenfed by Cold, the Air breaks in to prevent a Vacuum: For that Water is expanded by Cold, appears from what I have faid; belides nothing is more commonly observ'd than that Water being froze in a Vessel whose sides are strong enough to keep it from bursting them, the Superficies of the Ice is generally protuberant and convex. And that the breaking of Bottles depends not on Nature's abhorrency of a Vacuum, appears; fince should we suppose, That the Fluid contain'd in a Bottle would be so far condensed as to possess less space than before; it is possible there might be a Vacuum there, and the Bottle not burft; fince Glass-Bubbles much thinner than ordinary Bottles will endure the frost, tho' stopped close with Air in them.

But not only Water expands it felf upon freezing but other Aqueous Bodies; so Eggs being froze, burft their shells asunder. And Milk, Urine, Rhenish Wine, and good Spirit

of Wine being fet to freeze in diftind Glass-Fone the Wine being froze swell'd an Inch above the first Surface, the Milk two Inches, and the Urine fix or feven And a Solution of Danteit Vitriol, did not only become Opace, but rafe considerably higher in a Cylindrical Pipe, upon

Congelation.

Whether more stable and confistent Bodies are capable of being expanded by Cold; would be worth enquiring; fince it hath been observed. That in Nova Zembla the very Clocks have been froze fo that they would not goe; and the like bath been observ'd by Capt. James in his Voyage at Charlton-Island; his Watch being froze as well asthis Clocks. Whether these Effects depended on any Swelling of the Ropes, or whether the Spring of his Watch might be weakned by Cold, or whether some Iceicles fluck to the Internal Parts of it; I shall leave as bare Conjectures, to be further examined into by Experience.

The Phenomena of an Experiment about Freezing referrable to the VII Title, read before the Royal Society.

Having filled a Bolt-head which was as big as two Turkey Eggs with Water, till it rought, a pretty height into the slender Stem, being put into a Mixture of Snow and Salt, it sublided a little; but when it began to freeze it would fenfibly fwell.

The Experiment being repeated with a Glass whose Stem was as thin as a Raven's Quill; when first the Ball of it was immersed in the frigori-

fick

fick Mixture, the Water presently ascended the height of a Barly-corn, and presently subsided again, which the Florentine Virtuosi would attribute to a Constriction of the Glass upon the Application of the frigorifick Mixture.

Secondly, And the the Florentine Virtuesi, relate, That they have observed, the Water after it had subsided, a little to rest, and then subsided again; yet in all the Tryals I made I did not

observe it.

Thirdly, When the Water had subsided a little, it would be at a stand, till the Liquor

began to freeze.

Fourthly, The Experiment being try'd with Glaffes whose Stems were unequally big, upon Glaciation, the Ascent of the Water in the large ones would be indiscernible; but in a stender one it would ascend several inches in a Minute, till it rose up to the top of the Stem.

Fiftbly, Tho' the Florentine Academians, fay, they have observed the Water to rise again, before Glaciation; yet I could never see such a

Phænomenon.

Sixthly, If the Glass was taken out of the Mixture when first it began to freeze, as soon as the small Iceicles were melted, it would subside again; yet if reapply'd to the Mixture a second time, it would freeze in half a Minute.

TITLE VIII.

Experiments concerning the Contraction of Liquors by Cold.

Of the Contractions f Liques by Cold.

THO' the Liquors we have mention'd expand themselves upon an Intense degree of Cold, yet we are not thence to couclude, that all will; since we have found it by experience not only in Spirit of Wine, Aqua form, Oyl of Turpentine and several other Liquors which would not be brought to freeze; but also in Oyl congeal'd by the vehemence of the Cold.

2. Amongst the several Experiments made of the Efficacy of Cold to condensed Liquon, I shall lay down the following.

3 Spirit of Wine being put into a small Glass-Egg with a slender Stem, in a Mixture of Snow and Salt subsided 2 of an Inch.

4 Mercury being freed from Air, and placed in a Bolt-head in a Mixture of Snow and Salt, subsided 2 laches. Common Oyl placed in the same Mixture subsided till it froze; but if it were immediately thaw'd near the fire, it would expand it self so much as to rise about the Mark. The Experiment succeeded a second time, and being try'd a third time, the Lumps of the congeal'd Oyl would fink in the sluid Oyl. Oyl of Aniseeds artificially froze subsided considerably in a small Pipe. Empyreumatical Oyl of Gaujacum being exposed to the utmost

utmost degree of Cold, would not freeze; but evidently subsided.

Particulars referrable to the VIII Title.

1. Two feal'd Weather-Glasses, the one made of a Tincture of Cochineele in Spirit of Wine; and the other of a blew Tincture of Spirit of Man's Blood and Copper in Spirit of Wine; were immersed in Water till it began to freeze, and then being remov'd into Oyl of Turpentine fet in a Mixture of Snow and Salt; we observ'd, That the Liquor in both Thermometers subsided. Oyl of Aniseeds being put into a small Glass with a large Stem. and placed in a frigorifick Mixture made by a Solution of Sal-Armoniack Subsided 3 Inches; the substance of the Oyl being turn'd into a white Concrete, which when it was leafurely disfolv'd, the fluid Part emitted feveral Bubbles; and it was further observ'd in this Concrete, That tho' when thaw'd it swims upon Water, yet when congeal'd it will not.

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TITLE IX.

Experiments concerning the Bubble from which the Levity of Ice is supposed to proceed.

Of the Le-Coule.

TT is usually accounted an Argument of the levity of Ice above Water, that it swims upon it : For tho' the superficies of small Portions of it are not fensibly emergent above the Surface of the Water; yet in Greenland, where huge Rocks of Ice float in the Sea, they are observed to be as high above the Water as the Masts of Ships, which could we suppose to float in an erect Posture, and to be of a prismatical Form, that Part immerfed would be nine times as much as that above the Water. As for the Reason why Ice is born up above the furface of the Water so much in Greenland more than in our Climate; besides that the size of those pieces of Ice contributes to the rendring the Observation more remarkable, the Water's expansion in that cold Climate may cause it to be further expanded there than here, and confequently light-

2. Pieces of Ice free from Bubbles floated in Spirit of Wine drawn from Brandy, and likewife from Quick-lime; and tho' if that Spirit were warmed, it would prefently subside, yet as it cooled, the Ice would ascend; nevertheless some part of it being thaw'd, the Water would subside in a stream through the Spirit. In warm Water the Ice would fwim; but in Oyl of Turpentine and the rectify'd Spirit of Wine it would fink like a Stone.

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3. A piece of Ice which was clear from Bubbles, for as much as we could differen, and very transparent, would not fink in Water; but another piece, which in a Microscope appear'd to be full of Bubbles, was nevertheless transpa-

rent, and would float on Water.

4. That the levity and expansion of Ice depends on the number of Bubbles dispersed through it, is unquestionable; but how it comes by those Bubbles is a matter that deserves our Inquiry: And tho' Mr Hobbes attributes it to the Intrusion of some external airy Parts, yet we observ'd, That Water desended from the Intrusion of external Air, was not without Bubbles, when froze in a Glass hermetically sealed; but being expanded, the numerous Bubbles dispersed through it, gave it a whitish Opacity; and the same Phænomena were afforded by Ice froze in Metalline Vessels.

s. And that the Ice froze in the hermetically fealed Glass, received not its Bubbles from the Air thut up with it; is reasonable to believe: First, Since the Water must be expanded before it could divide that Air into Bubbles. Secondby, That the Air in the fealed Glass cannot be dispersed through the Ice, and thereby cause it to expand, appears; fince oftentimes it is fo far compress'd by the swelling Ice, that it breaks the Glass, which it would not do, could it be mixed with the Ice and dispersed through the freezing Water. But, Thirdly, Were the expansion of Ice to be attributed to the intinuation of airy Parts, it may be question'd, How, when Liquors begin to freeze at the bottom first, the Air, which is fo many times lighter

F a that



than Water, can dive into the bottom of it, and that too without being feen? Fourthly, li the Bubbles contained in Ice were deriv'd from the external Air depress'd through freezing Water, Ice thaw'd would yield Air enough to fill as much space as the frozen Water possess'd more than the thaw'd Water.

6. That the Bubbles contain'd in frozen Water are not adequately fill'd with Air, tho' fometimes the Air that they contain be afforded by those airy Parts dispers'd through the Pores of Water; and that they are often generated numerously, notwithstanding a recess of the greatest part of that Air, will appear from the following Experiments.

I. Water freed from Bubbles in Vacuo Boyliano, and afterwards convey'd into a frigorifick
Mixture expanded not fo much as common Water, nor was the Ice near fo full of Bubbles.

II. Water which had been freed from Bebbles in our Prismatical Engine, being froze, contain'd few Bubbles, but being thaw'd and then pour'd into a Glass-Cylinder, it was powerfully

expanded to far as to burft the Glass.

III. A Glass-egg with a narrow Stem being filled fo far with Water, that the surface of it rose an Inch within the Stem; it was convey'd into a Receiver, and whilst the Air was exhausting, Bubbles rose so plentifully, that the Liquor seem'd to boyl: Which when it was in a great measure cleared of, we placed it in a mixture of Snow and Salt; and observed, that the expanded Liquor being froze, had risen a great way above its first height. When it was placed in the open Air, of such a temper as made

made it thaw leifurely, we observ'd, That the exterior part of the Ice was full of Bubbles: But when that was disfolv'd, the Ice in the middle was of an unusual Texture; being void of Bubbles and not unlike a frosted piece of Glass, whose aspereties were very thick set : When the Ice was almost thaw'd, we convey'd the Bubble into the Receiver; but tho' the Air was exhausted, we perceiv'd not that the Ice was fooner melted ; but the Water afforded a few Bubbles, and in a little time some few appear'd in the Ice. When the Ice was wholly thaw'd, we took the Glass-Bubble out of the Receiver, and found, That the Water had subsided to its first Mark, if not a little below it; fo that the Water when expanded rising three Inches in the Stem, and the weight of the whole Water being but two ounces and a half; the Ice feem'd to take up about a twelfth Part more than the unfroze Water.

7. A Cylinder of Water being immers'd in a Mixture of Ice and Salt, and that convey'd into a Receiver; we found, That when the Air was exhausted, and the Water in a great measure freed from Bubbles, the surface of it was considerably rais'd; the Water in the bottom being turn'd into Ice as far as the Mixture wrought, in which we perceiv'd, besides a few large Bubbles, small ones enough to render it opacous.

8. To shew, that the Bubbles perceivable in Ice are not filled with true and springy Air, I shall subjoyn the following Experiment. We plac'd a Glass-egg, which was about as large again as an ordinary Egg, in a mixture of Ice and Salt; the Cavity of it being fill'd with Water,

F 4 which

which rifing up into the Neck, stood about an Inch above the superficies of the frigorifick Mixture which circumscribed it; the Diameter of the Stem being large enough to receive the end of my Finger. The Particulars afforded by this Experiment were.

I. The Water did not sensibly subside before

it began to freeze.

II. Some part of it began to swell in a quarter of an Hour.

III. In an Hour the Liquor rose 43 Inches, and continu'd to rise till it was above five Inches; when we took it out.

IV. The frigorifick Mixture being below the furface of the Water, it froze at the bottom first, leaving the top of the Water uncongeal'd.

V. No Bubbles appeared in the Water tho? the Ice was full of them, fome being as large as

fmall Peafe.

VI. We pour'd as much Sallet-oyl upon the Water, as wrought two Inches in the Stem, and then hermetically fealing the end of it up; the Water subsided a little, but was prefently rais'd again to its former height in the Mixture; about an inch and a half of the Stem remaining above the Oyl filled with Air.

VII. The Glass-egg being weighed first in Air, was left in the Water poiled with its opposite

weight ..

VIII. Upon the thawing of the Ice, several

Bubbles role which vanish'd at the top.

IX. The Water being thaw'd, the Aquilibrium continued the same, and subsided to its fift Mark and no lower, the it had parted with so many Bubbles.

X. The

X. The Glass being inverted, the ical'd end was broke off under Water; upon which some of it being forced up into the Pipe, press'd the contain'd Air into less room than before.

XI. The Water and the Oyl possess'd the same

Places that they did before.

XII. The Oyl being thrown out, and so much Water put into the Stem as rais'd the surface as high as it was rais'd by Glaciation; the Glass weighed 4374 Grains: When fill'd to the lowest Mark it weighed 4152, and when empty 1032; so that the Water contain'd betwixt the two Marks, was about the 15th Part of the whole.

10. A large Glass-egg with a proportionable Stem, being so far fill'd with Water, that it wrought up an Inch into the Stem; the next Day the Water was rais'd 15 Inches: The whole contain'd in the Cavity of the Egg being froze; the frozen Water continuing to swell, was rais'd 4 Inches higher, a few drops running over the top of it; but when the Ice was wholly

thaw'd it subsided again.

in Another Egg about the same height, being plac'd in beaten Ice and Salt, the Water rose an Inch in an Hours time, and several Laminae of Ice appear'd at the Jointure of the Ball and the Neck; but after an Hour and a quarter, those disappear'd, and the Ball seem'd to be fill'd with white Ice; the Water in the Neck being rais'd 41 Inches above the first Mark. Several small bubbles ascended through the Neck till it was wholly thaw'd, and the white Ice was full of Bubbles. The Experiment being surther prosecuted, the Water swell'd

fwell'd till fome of it ran out at the top of the Tube: Upon which, the top of it being feal'd up, we plac'd it in a warm Room till the Water was quite thaw'd; fo much Air only-remaining above the Water when froze as in dimensions equall'd a small Pea. When the Ice was wholly thaw'd, the Water subsided to its first Mark, and then the top of the Stem being broke off under Water; fo much of it was impell'd by the external Air, as, when the Pipe was re-inverted again rose 7 Inches, above the first Mark, and left about an Inch & above it; fo that the Air which caus'd the Water when froze to swell, and which was generated there, took up one Inch and 1: Which being expanded through the Cavity of the Cylinder, above the furface of the Water when thaw'd; fo far appear'd not to be Air, that it wanted a Spring to refift the ingress of the Water.

12. Another time the tip of a feal'd Stem being broke under Water, it received 10 Inches

and above :

13. In the same Bolt-head wherein the greatest condensation of Air was try'd, the Water being froze, was rais'd a Foot above its former station; and then being feal'd up, and leasurely thaw'd, it subsided again to its former Mark: And then the Seal being broke off under Water, so much of that contain'd in the Basin was forc'd into the Tube, as sill'd 11 Inches of it; near; of an Inch of Air being generated in the former part of the Operation.

14. Another time the Water swelling 10 Inches in the same Glass, we broke off the Neb under Water, and it received as much of the





external Water; fo that in this no Air was generated.

15. The like Experiments being try'd with aqueous Liquors; the Neb of one that contain'd Milk being broke off under Water, it was manifeftly impell'd by the outward Air. And another being likewise open'd under Water which contain'd Urine, it receiv'd about five or fix Inches of Water.

16. Another Glass which contain'd Claret-Wine, being open'd under Water, the Water was impell'd near an Inch above the Mark; which would not have happen'd, had the Bubbles been fill'd with true and permament Air.

TITLE X.

Experiments about the Measure of the Expanfion and the Contraction of Liquors.

O measure the expansion of the Air, we The expansion took a Bolt-head, and pour'd in fo much contraction Water, that it rose a little way into the Stem; of Ligar which being done, and the number of Ounces it contain'd fet down, to those we successfully added one Ounce after another; marking how high each of them wrought: Which being done, we pour'd out a convenient quantity, and froze the remaining Water from the bottom upwards, and the Ice that confifted of 82 parts of Water, filled the space of 91 and 1; so that the congeal'd Water posses'd a oth part of space more than it

did before. In another Experiment ss Parts of Water being froze, were extended to 60 1: 6 of

those remaining unfroze.

2. Another way we took to measure the expansion of Water, was, by marking a Cylindrical Pipe at the super ficies of the Water contain'd in it; which, when it was froze, was rais'd a tenth part higher than before. Another more exact Cylinder being made use of, we found. that Water froze expanded to about a ninth Part of the space it posses'd before.

3. But perhaps this Method of measuring the expansion of freezing Water may singgest a difficulty to those that are acquainted with Hydrostaticks : fince Archimedes hath made it appear, as well as Stevinus Toat floating Bodies will fo far and but so far, fink in the Liquor that supports them, till the immersed Part of the Body be equal to a bulk of

Water, weighing as much as the whole Body. 4. For Capt, James hath observ'd Ice to float a great deal above the Water; and the Hollanders in their Voyage to Nova Zembla, take notice of a Hill of Ice which was 16 Fathom above the Water, tho' but 36 below it : And James Munkius in his Account of Greenland, observ'd, That one that was but 40 Fathorn under Water, was 20 above it; whereas according to our Computation of the expansion of Water, the Part under Water ought to be 8 or o times as deep as that above it.

5. But to clear this difficulty I have these things to represent; First, That the Ice which we take notice of, floats in fresh Water, but that observ'd by Navigators being fresh floats in falt Water; yet this is to be likewise consider'd. That near the Poles the Seas are not fo falt as ours, or

those

those under the Line, and consequently will not be able to bear up the floating Ice so high; except the coldness of that Region recompenses

the want of Salt.

6. But befides thefe Confiderations, that which I would chiefly infift upon for the removal of this difficulty, is, That thefe hage Piles of Ice are made up of vast Lumps, betwixt which are large Vacuities which are only fill'd up with Air : fo that we are not to judge of their weight by the bulk they appear to be of to the Eye; but by the specifick weight incumbent on that part immers'd in the Water : For we fee in Barges, that fometimes they carry Loads, which confifting of light Matter, may be piled a great height above the Water, without depressing the Vessel so much as heavier Bodies of less bulk, which are more ponderous in Specie; for the greatest part of these floating pieces of Ice, as Bartholinus takes notice, are compiled of store of Snow frozen together. Besides, it is observ'd, That most of those stupendious Mountains which lay so much above Water below rested on the Ground, fo that probably they might have funk much lower, had the Water been deep enough for them; for Mr. Hudson in his Voyage takes notice, in a Bay that bears his Name, of a piece of Ice sevenscore Fathom deep.

7. Having said thus much of the expansion of Water, it perhaps may be expected, that I should say something of the expansion of aqueous Humours; and also of the degrees of the Condensation of Water and watry Humours: But as for the first, I doubt whether there be any expansion, except of the watry Parts of them; but if it may be of any use to



direct us in making an estimate of the different Proportions they contain of Phlegm, or other more spirituons lagredients; I would not discourage those whose Curiosity shall prevail with them to prosecute such Experiments. And as for the condensation of Water by Cold, tho perhaps in hotter Climates it may be considerable, yet I have not found it very sensible in all the Tryals I have made here.

Particulars referrable to the X Title.

i. A Bolt-head whose Stem was 17 Inches above the Water being seal'd up, and placed about 9 hours in a frigorisick Mixture, the Water ascended 15 Inches 3 and afterwards 4 of 3 of an Inch; being neglected for an hour the seal'd end was blown off, and the Bottom

of the Glass broke in peices.

2. Water freed from Air in. our Receiver, and seal'd up in a round Bolt-head, in which the seal'd Apex was about 5 Inches above the Water, afforded an Ice very free from Bubbles, and having stood in a frigorifick Mixture about 2 hours, it was raised 4 Inches and 1: The Conical Apex being broke with a noise and a seeming smoak, we found Water unfroze, under the Pipe, and that the Air was condensed to a 20th Part of the space it posses defore.

3. The Globous part of a Glass-Egg 3 Inches Diameter was filled with Water and froze from the Bottom upwards; after it had been Hermetically seal'd, it rose 81 Inches, the length of the whole Stem being 10 Inches and a half. But being a second time sealed up and

froze

froze with Ice in it, it wrought not 4 Inches above its first station.

TITLE XI.

Experiments touching the Expansive force of Freezing Water.

1. TO help us to make an estimate of the Expansive force of freezing Water, We filled aPewter-Bottle full of Water; it being large freezing enough to hold half a Pint : In a frosty Night it Water. crack'd the Bottle; and the like fuccess we had with frozen Water in a Pewter-box, such as they keep Salves in. And we found the Expansive force of Frost so strong, That it burst a Bottle, the thinnest part of which was 14 of an Inch, and the thickest is : It also broke an Earthen Bottle of Flanders-Metal, the thinnest part of which was as thick as the strongest of the other.

2. To make a more Determinate Estimate of the Expansive force of Frost; we made use of a Brais-Cylinder, to which we adapted a Plugg, which falling a little way within the Cylinder rested upon the edges of it. length of the Cylinder was about 5 Inches and the breadth 14 The Experiment made in this Instrument was by filling it full of Water and then laying 56 pound weight upon the top of it: And tho' it was a hard matter to cause the Mixture to freeze; yet we were at the last able to do it, and then we observ'd, That the Expanded

panded Ice lifted up the one fide of the lower fo high, that the weight fell down; but at another time it succeeded so well, that the lower was uniformly raised the breadth of a Barly-corn: " Upon a gentle thaw the Superficial Parts being taken out, the Ice appear'd full of Bubbles : And in the Morning when it began to melt before the fire, the weight being taken off; several drops of Water, dilated into numerous Bubbles, iss'd out, like a kind of Froth.

3. Another way we took to measure the Expansive force of Cold, was, by driving a Wooden Plugg so fast into the end of the Brass-Cylinder, That half a hundred weight and a quarter of a hundred, might be suspended at it without pulling it out; yet in two frosty Nights the expanding Water was able to raise it a

quarter of an Inch.

4. There is one thing in thefe Tryals deserves to be taken notice of, viz. That the Expansion of Air by Heat being sufficient to make it posless 70 times it's former space; yet the utmost degree, Water by Glaciation will extend it felt to, is a ninth; So that the former by Expansion acquires 60 times the space that Water does; taking Mersennus his account of the Air's Expansion to be true, which comes, short of what we have shewn it capable of being Expanded to.

s. We endeavoured likewise to measure the force of Waters Expansion when congeal'd, by enclosing it in a Iron-Globe whose Diameter was about 3 Inches, and which had a Female Screw continued from it's Cavity to the out fide; to which was adapted Male a screw fo close,

That

That we were forc'd to use a Vice to screw it in ; but our hopes were frustrated; the Compactness of the metal, as we supposed, keeping-

the Liquor from freezing.

6. It would be worth while to confider the canse of so powerful an Expansion, since neither the Cartesian nor the Epicurean Doctrine are able to explain this Phænomenon: For the first only accounting Cold to be a Privation of Heat; and depending upon the recess of those fubtil Parts, which he supposes Expansion to depend on; according to him, they should rather continue an Inactive Mals, than retain fuch a Springyness. And fince according to Epicurus, Expansion depends on an Infinuation of frigorifick Atoms, It may well be question'd, how parts of Matter, which have fuch a free entrance into fuch Veffels, should not rather find as easie a Passage out again as in, without breaking them ? Besides in several Oyls and other Liquors which must receive those frigorifick Atoms we perceive not the least Expansion at all; but they are rather condensed.

7. How great the Expansive Force of congeal'd Wine, Milk, Urine and other Liquors is, I shall leave it to others to enquire, and shall only take notice, That undoubtedly it is considerable; since in the Dutch Voyage to Nova Zembla it was observ'd, That even Iron-hoops were burst by the forcible Expansion of included Liquors. And in Russia it hath been observ'd, that tho' Beer and Wine would not burst Wooden Vessels, yet Glass and Stone-Vessels

would be often broken

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Particulars referrable to the XI Title.

1. We took a Brafs-Cylinder 2 Inches Diameter, and having put a Bladder with Water ty'd close up in it, so that upon Expansion it could not get out into the Cavity of the Cylinder; we put a Plugg into it, upon which were placed several weights; which amounted to 120 Pounds, yet the frigorisick Mixture being apply'd to the Cylinder, the Water expanded rais'd the Plugg, near half an Inch; and the Experiment being repeated again the next Day the freezing Water raised 130 Pound-weight.

2. An Iron-Barrel 14 Inches long and 1 of an Inch in Diameter, whose sides were at the thickest Part 16 and at the least 14; was filled with Water, and being buried in a Mixture of Ice and Salt 2 hours, it made an oblique crack in the Barrel Six Inches long; and the lee being taken out seemed full of Bubbles but very small ones; and the like success we had with another Barrel of a Gun, whose Muzzle and Touch-hole were stopped up with Metal; nor had we less success when we buried a Pewter Bottle in a frigorisck Mixture, both the Barrel of the Gan and the Bottle being burst in a quarter of an hour.

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TITLE

TITLE XII.

Experiments concerning a new way of Estimating the Expansive force of Congelation, and of highly compressing Air without Engines.

TOW far we were able to compress the Anm way Air by the Incumbent weight of a Cylin of Estimader of Mercury, we have elfe where flewn ; but panice to reduce it to a greater degree of Condensati- force of Con-

on I made the following Experiments.

1. Having filled a Glass-Egg with Water till it wrought about an Inch into the Stem, we placed it in a Mixture of Snow and Salt, and in a few hours the Surface of the Liquor was raised about 7 Inches; and the Apex of the Stem being sealed up, by a fresh application of Snow and Salt it was raised 8 Inches higher: So that the Air being compressed into the space of an Inch, poffessed about nine Parts of ten of what it did before: Whereupon the Stem being inverted and the feal'd end opened, the Air which when the Stem was inverted, rose up to the Ice, and Teparated the unfrozen Water in the Stem from it, powerfully expanding it felf; forced out about ten Inches of Water, with Violence and Noise, besides a great number of Bubbles ascended from the Bottom of the Glass to the Top. N. B. when the Air was compreffed beyond seven Inches, we several times obferv'd, That the Glass just above the Water on the

the infide was full of little drops of Dew, which when the Apex was broke off Disappeared.

2. A Vial whose neck was drawn out into a stender Pipe, being filled till it wrought an Inch within the Pipe; in a little time, by the Expansion of the Water, the Air being too much compressed, the head of the Pipe slew off; and the same happened to a round white Glass whose Stem, filled with Air, was about 3 Inches: Nor was the success otherwise when we repeated the Experiment in a large single Vial, whose Stem was four Inches long, and it's Basis

an Inch broad.

3. An Oval Glass about the fize of a Turkeys-egg, with a neck almost Cylindrical, was filled with Water within four Inches and a half, and then a piece of Paper being pasted upon the Stem divided into half Inches and quarters, and the Apex being fealed up by a moderate Heat; the Surface of the Water was raised considerably, but the Oval Part of the Glass being covered with a Mixture of Ice and Snow the Air was compressed into a 17thPart of the space it possessed before; And the Ball of theGlass bursting afterwards with a considerable Noise, the Ice appeared full of Bubbles, which rendred it white and Opacous. In another Glass whose Ball was larger in proportion to the Stem, the Air was compressed into a 19th Part of it's former space before the Glass flew in pieces.

3. And this way of trying how far the Air might be compressed and Water expanded by Cold, we thought least Exceptionable; because the Pores of Glass are more impervious to Air

and



and Water, than fome Metalline Vessels; for having broken open the Apex of the Stem of one of our Glass-Eggs, we found, that the the Water was but a little expanded; yet not finding a way out at the Pores of the Glass, the Water rose up a quarter of an Inch.

TITLE XIII.

Experiments and Observations concerning the Sphere of Activity of Cold.

In estimating the Sphere of Activity of Cold, of the we are not only to consider the Degree of Activity of it in the cold Body; but also the Medium through Gold. which it is to pass, and the Consistence and Texture of it; as likewise the Instruments employed to receive or acquaint us with the Action of Cold: Since, from what hath been before laid down, it appears, That Weather-glasses give us a more nice account of the Degrees of it; and that our Sensories may mis-inform us, upon the account of their various Predispositions. Besides the Sphere of Activity may be varyed by the Bulk of the cold Body.

1. But to consider the Sphere of Activity of small Pieces of Ice; we have found it very small in comparison of the Atmospheres of odorous Bodies; insomuch that I am perswaded, we can have no sense of Cold, without the immediate Contact of a cold Body; since Ice approaching our Sensory, or a Weather glass, asfects neither; tho held as near as possibly they may without touching. And the like hath been

observ'd

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observed at Sea, where in foggy Nights the Seamen have not been able to discern neighbouring Mountains of Ice: Tho by a Merchant who made the Observation in Greenland, I am told, That he perceived a manifest access of Cold, upon the

approach of a floating piece of Ice.

2. And I am told, that in Ispahan the Capital Gity of Perfin, the Ice being never much more than a Finger thick, they usually pour Water upon it, which as it runs over the Ice, is in part froze, by which means, they thicken the lee and preferve it in proper Confervatories. This Experiment having been tryed in England, by pumping of Water upon Flakes of Ice; I found, That the Pump-water, being warmer than the Ice, thawed it, instead of increasing the Thickness of it. And tho' here in England, Water poured upon Snow promotes its Diffolution, yet in Russia and Muscovy I am told. That Water thrown upon Snow freezes it; which they therefore make use of to incrustate several Bodies with Ice; yet one thing is to be observ'd, that generally at the same time, the sharpness of the Air is fo violent, as to incrustate feveral Bodies with Ice, when only Water is made use of; so that in trying fuch Experiments, we are to consider the Temperature of the Air at the same time, which hath a great Influence in promoting or varying the Effects of fuch Tryals.

3. How deep Frost penetrates into Water and Earth will be a very hard thing to determine; fince Earth especially, may be more or less disposed to freeze, according to the several Degree of Cold, and its Duration; the Texture of the Earth, and the Nature of the Juices disposed

Lin ugh



through it, or subterraneal Steams: Whence large Tracks of Land that lye over some Mines, are always free from Snow, good quantities of Limestone being near the Surface of the Earth.

4. But the it be so difficult to know to what Depth Frost will reach, yet that we may contribute as much as we can to the general History of Cold, we shall add the following Notes. After four Nights hard Frost the Ground in the Orchard was froze about 3 Inches deep, and in the Garden about 2; after ten Nights Frost, the Ground in the Garden was froze about 6 Inches 1, and that in the Orchard was froze 8 1 or more. Eight Days after, it was froze about a Foot Deep.

5. A Pipe of Glass 18 Inches long being thrust down into a Hole in the Ground, the Surface of the Water contained in it being level with the Earth; the next Morning the whole Capacity of the Cylinder was froze 3 Inches, from which Stick of Ice a Part of the Cylinder was froze 6 Inches deep; but the rest of the Water remained unfroze: The Ground in the Garden,

that Night was froze ten Inches deep.

6. It hath been observed, that in Moscow the Ground in a Garden was not froze above two Foot deep; but Capt. James says in Charlton-Island he observed the Ground froze ten Foot deep; and the same Author in his Journal, p.86. says, That the Water does not freeze naturally

above fix Feet.

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One Particular referrable to the XIII Title:

I am told, That a Lee-ward of great Banks of Ice, they may discover them by the access of Cold, twenty Leagues.

TITLE XIV.

Experiments concerning the Different Mediums through which Cold may be diffused,

diums through may be dif-

of the Me- IN trying these Experiments we are to take Notice, that the Mediums are not to be too which Cold thick; fince, from Experiments already deliver'd it appears, That a compact Medium very thick will not give way to Cold.

1. Having placed a Mixture of Snow and Salt in a Pipkin, and another in a white Balin glazed within and without, they were both incrustated with Ice. And that Cold will penetrate Pewter-Bottles, appears from Experiments already laid

down.

2. Having caused two Cups to be made of Lattin or Plates of Iron covered over with I in the Convex Part of one of which, was less than the Concave of the other; and the less having a broad Ledge, by the help of which it rested on the Brim of the other, so as to leave an Interval betwixt its Convex Superficies and the Concave of the other; we filled that Interval with Water, and putting a Mixture of Ice and Salt within the less Cup, and on the outside of the other, we had Cups of Ice made of the inclosed Water. 2. The



12. The Learned Erasmus Bartholinus in his discourse De figura Nivis mentions an Experiment by which Air is turned into Water in the midft of Heat, viz. Ice or Snow being put into a a funnel; which he supposes refrigerates and condenses the Ambient Air; but I rather think. That the Dew which he supposes to be conflenfed Air, is made up of moist Vapours fwimming in it; which is fo fmall in Quantity, That having fuspended a Tunnel in the Air, with a Mixture of Snow and Salt; which is much more refrigerating than either Ice or Snow by themselves, it gathered but a very fmall Quantity, and that too lasted no longer than whilft the Mixture was diffolving; besides those condensed Vapours were first Froze before they dropped down in the form of Water.

3. That in Hermetically sealed Glasses, a Mixture of Snow and Salt will freeze Vapours on the outside, is evident, from what hath been laid down; but that Cold should not only penetrate Glass, but afterwards act upon Water in Vacuo; was a little more strange: For having suspended a Tube of Water in Vacuo and piled Snow and Ice about it, as high as the Included Water wrought; it worked upon it, and

Froze it from the top to the bottom.

4 But what is yet more strange is, That Cold will act through a evidently hot Medium; for drinking a good quantity of Mineral Waters timely in the Morning, I observed a Manifest Coldness through the Muscles of my Abdomen, which was in a higher degree remarkable in a Gentleman who drunk much greater quantities.

S. To

r. To try whether the fluidity of Water depended on a Congenite motion in the Parts of it, or whether it was conveyed to it by impulse from the Ambient Air : we provided a Glass-Bubble about the fize of a Wall-nut and of a Pear like shape, whose Stem was purposely made crooked, and suspending it by a thread in Oyl of Turpentine contain'd in a narrow Glass; and this being placed in a Mixture of Snow and Salt, tho' the Oyl continued fluid; yet the Water in the Bubble was froze. And when we went to take it out, the Bubble being crack'd, the greatest Part subsided to the Bottom of the Mixture; but we perceiv'd, That, that which was pulled out, was divided by a line through the middle from the top downwards. And it was further observable in this Tryal, That the two separable Pieces of Ice, being left in a Mixture of Ice and Salt for 14 hours, were very little wasted. The like foccess we had with a Bubble of Water fulpended in Spirit of Wine; but another fufpended in Sea-Salt was not froze at all; nor was another that we hung in a sharp brine: But the same Experiments being tryed another time; the Water was froze both in the Bubble fuspended in Spirit of Wine, and in that which was immerfed in the strong Brine; the Bottle which contain'd the latter being crack'd, which cracks were not much unlike the lines drawn from the Pole of a Globe to the Meridian; reaching from the top of the Bubble down-



6. A Bubble fulpended with Water in it. in a Glass immersed in Snow and Salt, was froze, without the Intervention of any Liquor.

TITLE XV.

Experiments and Observations concerning Ice.

T'HO' in the East-Indies it hath been thought Ice. frange, That Water in England fhould without any Artificial means be turned into a confiftent Body; yet it is related by fome. That in Russia the Ice on the contrary, is found

much harder than Ours.

2. To make an Estimate of the Cohesion of the Parts of Ice, we thought to have tryed what weight Cylindrical pieces of Ice of different Diameters would bear : But being frustrated in fuch Tryals, we try'd how much weight a Plate of it placed betwixt two Iron-Bars would bear; but having not convenient weights we were forced to be content to know, That it bore a much greater weight than one could suppose it capable of.

3. A peice of Ice 3 Inches long, and as many broad; and about of an Inch thick was laid cross a frame; and a peice of Iron of this Figure (7) having a scale hung at the longer Leg, the Horizontal Leg was placed upon the middle of the Ice; and then 117 Ounces Troyweight being put into the Scale, when the Iron had melted half the Ice through on one fide,

and



and a third Part of the other, the weight was able to break it. The Experiment being repeated when the piece of Ice was 2 Inches and a half long, it bore 17 pound Averdupois and 48 Ounces Troy-weight, when the Iron on one fide had melted 3 and on the other 2 Parts of

the thickness of it.

4. Plates of Ice being laid upon a stool, and Bay-salt strewed on some Parts of them, they promoted the melting of the Ice so much, That they buried themselves in it; but the Parts thaw'd by this means, were so incorporated with, and froze to the stool, That we could not separate them without knocking them in pieces; At another time Salt thrown upon Ice made a crackling Noise and by a Candle-light, several Steams were observed to rise from them, like from some hot Liquors: A sew drops of Aquafortis dropped upon Plates of Ice, and Oyl of Vitriol, the latter sooner penetrated but the former with more Noise as if the Ice were crack'd.

5. Olaui Magnus Gent. Septentr. Hist. Lib.
1. Cap. 14 says, of the strength of Ice, Glacies prime & medie byemis adid fortis & tenax est ut spissitudine seu densitate duorum digitorum susserum susserum ambulantem, trium verd digitorum Equestrem Armatum; unius palme & dimidie, turmas vel exercitus militares; trium vel quatuor palmarum integram Legionem vel myriadem Populorum quemadmodum inferius de bellis byemalibus memorandum erit. But this account is the less satisfactory; because he tells us not how sar distant from the shore this weight



weight would be born, for the weight of one Man may be much greater at some distance from the shore than of more, upon or near the side; since the shore hath there a greater strength

to support it.

6. Purchas Lib. 4. Cap. 13 fayes, That the Ice in Russia was as hard as a Rock; and it is observed by the same, Lib. 4. Cap. 13. p. 813, That the Ice which floats in the Sea being taken up and thaw'd yields fresh Water; but whether it consists of an accumulation of fresh Particles in the Sea, or whether it is a Collection of Ice carried thither from some fresh Water I much Question; since the main Ocean is seldom froze, and especially since Purchas Lib. 3. Cap. 7. says, That the floating Ice near Nova Zembla which closes up the straight of Weigals slows down from the Rivers Oby and Jenesre and several others.

7. As for the bigness of some Pieces of Ice they seem almost Incredible; the Dutch in their Voyage to Nova Zembla take notice of one 96 foot high; and Capt. James hath met with some as deep under Water, besides what sloated above, and some much higher: And Purchas Lib. 4. Cap. 18. p. 837. Tells us of a Mountain of Ice which was 140 fathom high. As for the Length of these pieces of Ice, all that I can meet with is an observation of Capt. James's who measured a peice of Ice which was

1000 paces long.

8. As for the bigness of concrete Pieces of Ice, Mr. Hall in his Voyage to Greenland takes notice of one 24 Miles long. And by another, a vast Tract of Ice hath been observed, which

was

was fo long that the Bounds of it could not be discover'd from an indifferent high Hill. To which we may add what the French Hydrographer Fournier relates in his Passage to Canada, That he met with some Pieces of Ice as big as Monn. tains; others, as Ships; and one 80 Leagues long; in some Places plain, and in others unequal with high Mountains. And Olaus Magnus, Lib. 2. Cap. 2. pag. 284. fays, Neque minori bel. landi impetu Sueci & Gothi fuper aperta Glacie, quam in ipfa folidiffima Terra confligunt : Imi ut prius dillum eft, ubi antea aftivo tempore, acirima commissa sunt Bella navalia, itsdem in locis Glacie concretà, Aciebus militari modo construcio, Bombardis ordinatis, babentur borrendi conflictus, aded solida Glaties est in Equestribus Turmis fulferendis, ampliter vel stricte collocatis. And it is known to us all, that not long fince, the King of Sweedland and his whole Army marched over the Sea to Zeeland, where Copenbagen the Capital City of Denmark Stands. And Bartbolinus, de Nivis usu, takes notice, That in the Eastern Regions the Sea hath been froze a confiderable Depth. To which I shall subjoyn that Glycas apud Fournier, Lib. 9. Cap. 19. observes, That in the Year 775, the Mediterranean was froze for 50 Leagues, 30 Cubits thick, upon which as much Snow fell as raised it 30 Cubits above the Top of the Water.

o To what Instances we have already recited, we shall add that of the Dutch-Men in their Voyage, viz. that some pieces of Ice which were 18 Fathom below Water and ten above, were very blue; the like to which Capt. James takes notice of; and Virgil, speaking of the Frigid Zone, says,





Carulea glacie concreta, atque imbribus Atris.

Magnus to be much less compact than in the Winter; and it is attested by the same, and also by Mr. James Hall in his Voyages, that when these Rocks of Ice break they make a vast Noise; and the like hath been observed by others: And tho? Olaus Magnus attributes the cleaving of these Rocks of Ice, to the Effect which warm Exhalations have upon them; yet I am told, that sometimes they are observed to sly in pieces upon excessive Cold.

Particulars referrable to the XV Title.

1. A Decoction of Sage, Rosemary and Parfly being exposed to be froze in distinct Vessels, the Superficies of the former was very rough. Juice of Lemons froze, represented Trees without Leaves.

2. Hard Ice beaten, and common Salt being mixed together, afforded white Fumes like Smoke, tho' the Experiment was tryed in a close Room. Snow-Water froze in Ice and Salt, afforded an Ice very transparent, and with minute

Bubbles.

3. Ice partly powder'd, and in part grosly beaten, being mixed with Bay-salt, when the Mixture was stirred, afforded a sensible Smoak, which was greater or less as the Mixture was more or less stirred; and sloading over the Brim of the Vessel, rather sunk than rose; just as the Fumes

Fumes do from a Cloth dipped in Aq. fortis and

hung up to dry.

4. I am told by one who was in the Frigid Zone, that he supplyed himself with fresh Water from the Ice, by digging Pits in it; and the fame Person tells me, That he hath observed Pieces of Ice so Fathom deep, which were not above a tenth Part above Water: Hellikewise observ'd near the Coast of Greenland, the Variation of the Compass to be 22 Degrees; and a little time after scarce any thing at all. He told me forther, That failing in the Main Sea in the Height of 77 Degrees, his Ship was furrounded with lee 'till the 4th of June; and the Ice opening he failed through it; Part of it passing along towards Hudson's Streights. And it is observ'd, That these Mountains of Ice much weaken the strength of Winds, infomuch that if they be driven near them by a Storm, the Wind is fo much quashed that they immediately find a Calm.

TITLE XVI.

Experiments and Observations concerning the Duration of Ice and Snow, and the destroying of them by the Air and several Liquors.

O discover what Liquors Ice would be foonest dissolved in, we contrived to freeze Water in a long Cylinder; which being loofen'd by applying a warm Hand, we divided fome into Pieces 1 of an Inch long, and others into Inches, and our Experiments being made with these Cylindrical Pieces of Ice:



In the first Tryal.

i. In Oyl of Vitriol, a Cylindrical Piece of Ice of an Inch in length lasted 5 Minutes.

2. In Spirit of Wine 12 Minutes.

3. In Aqua fortis 12 3.

4. In Water 12 Minutes.

. In Oyl of Turpentine about 44 Minutes.

6. In Air 64 Minutes.

The second Tryal.

i. In Oyl of Vitriol an Inch of Cylindrical Ice lasted undissolv'd a Minutes.

2. In Spirit of Wine 13 Minutes.

3. In Water 26 Minutes.

4. In Oyl of Turpentine 47 Minutes.

5. In Sallet-Oyl 52 Minutes.

6. In Air 152 Minutes.

a. We likewise thought it worth while to try, what difference there would be in the Duration of Pieces of Ice, of the same Bulk and Figure, but of different Liquors; as also whether Attrition would contribute to the Dissolution of Ice, which lobserv'd it did: Whence it appears, That as the Agents contiguous to Ice are different, they dissolve it's Texture sooner or later, and it snow or Ice be kept in a Place where neither the Sun nor the Air hath much Instuence upon it, it will continue a long time.

An Appendix to the XVI Title.

1. In confirmation of what was faid in the Close of this Title. I shall add the following Account of the Italian Conservatories, fent me by my ingenious Friend Mr. J. Evelyn: "The "Snow-Pits in Italy, &c. are funk in the moft " folitary and cooled Places, commonly at the " Foot of some Mountain or elevated Ground, " which may best protect them from the Meri-"dional or Occidental Sun; 25 Foot wide at " the Orifice, and about 50 deep, is esteemed a " competent Proportion. And though this be " excavated in a Conical Form, yet it is made "flat at the Bottom, or Point. The Sides of "the Pit are so joyced, that Boards may be nail-" ed upon them very closely jointed. Abouta "Yard from the Bottom, is fixed a strong Frame " or Trefle, upon which lyes a wooden Grate; "the Top or Cover is double thatch'd, with "Reed or Straw, upon a copped Frame or Roof; " in one of the sides whereof is a narrow Door-"case, hipped on like the Top of the Dormer, " and thatched-

To Conferve Snow.

"Wattle, so as to keep the Snow from running through, whilst they beat it to a hard Cake of an icy Consistence, which is near one Foot thick; upon this they make a layer of Straw, and then Snow, and Straw again; and continue S.S.S. 'cill the Pit is full, and then laying Straw or

" or Reeds upon all, they keep the Door locked. "This Grate is so contrived, that the Snow "melting by any Accident in laying, or ex-"traordinary Season of Weather, it may drain "away from the Mass, and fink without sta-"gnating upon it, which would accelerate the " Dissolution; and therefore the Bottom is but

"very flightly fteened, &c.

2. And it hath been observ'd by the Dutch-Men in their Voyage to Nova Zembla, That in June, the Sun was not powerful enough to melt Snow: And even in warmer Climates, where the Reflection of the Sun-beams is not fo confiderable, Snow continues unthawed all Summer; as upon the Top of the Alps, and other high Mountains. And Capt. James observes, that, in August, Ice that was kept in the Sun-beams, continued unmelted 8 Days or more; and the fame Author observes, that the very Ground was frozen in June.

TITLE XVII.

Considerations and Experiments concerning the Primum frigidum.

HO feveral Sects of Philosophers have Of the Pris disputed about a Primum Frigidum, some gidum contending for Earth, others Water, others Air, and another Sect for Nitre; yet I am apt to believe, That there is no such thing as a Primum Frigidum, or rearry Axlixor, in which that Quality principally refides, and from whence all other Bodies derive theirs; no more than that H 2 there

there is a ream Aulin, or Principle Subject of Relidence for any other Quality: For if an intense Degree of Motion amongst the minute Parts of a Body, be sufficient to give it the Onslity of Heat; it may be enough to render a Body cold that that Motion is diminished upon a removal of its Caufe; so that it may be doubted whether Cold be a positive or a privative Quality.

The Earth . 2. Indeed Plutarch Supposes the Earth to be not the Pri- the Summum Frigidum : But we daily fee, That

Frigi- it is froze by the contiguous Air communicating Cold to it, and, by the Interpolition of another Body, may easily be preserved from that, So the Salt-Works upon the Marshes of the Island Xaintonge in France, are preserved from the Dammage the Frost would do them, by letting in Water, by Sluces, to overflow them. Besides, were the Earth the Summum Frigidum, it might justly be wonder'd, why it congeals not the Water contiguous to it, fooner than Hail or Snow in the Air? Since Terrene Parts of Matter cannot be brought thither without some Cause able to elevate them, and perhaps to alter the Qualities of them. Not to mention those Vulcano's which argue the Earth to abound with Subterraneal Fires; and that in feveral Places where there are no fuch Vuleano's, as in deep Mines, those that work there, find it very hot and troublesome: And in deep Wells, it is observ'd, that the Water is so far from being froze, that it comes up reaking hot; which cannot be supposed to proceed from the Beams of the Sun, fince it hath been observ'd by Monsieur de Claves, Livre 11. Chap. 8. That in the Southern Countries the Heat of the Sun penetrates not above fix or fe-

ven Foot deep. And the subterraneal Parts are fo far from being extremely Cold. That it is observ'd by Miners, That the lower they dig. the more Vapours, exhalations and Heat they find, And Jo. Baptista Morinus, witnesses, That in Mines in Hungary four hundred fathom deep, after the descent of 80 fathom, it is always hot; but whether these may proceed from Subterraneal Fires or a Mixture of other Bodies I shall not determine; fince I have feen Bodies actually Cold mix'd together produce Heat. And I am told, That in some Parts of England they dig up a Mineral, which, upon an Addition of Water only, becomes Hot; and for a like reason perhaps those Heats in the Hungarian Mines may be caused: For that Mineral Steams afcend, is evident, fince they have been observ'd in a Perpendicular Groave not only to flink but by their Corrofive Qualities. to corrode the wooden Ladders. And Morinus himself tells us, That descending into the Golden Mines at Cremnitz, the Heat increased extremely as he descended; which they attributed to a Mine of Smaragdine Vitriol, which lay under it; of which kind of Vitriol, there is some, even in the Cold and Superficial Region of the Earth.

3. But if against what hath been said it should be alledged, That by the Primum Frigidum they only mean some Earth Mixed with the common Parts of the Terrestrial Globe, I should be glad to know, how we must discover this. But tho' I have brought these Arguments against this common received Notion; I cannot agree with Gassendus, who thinks, that the Earth is

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no more Cold than Hot: Since it being naturally a Body whose Parts are inclined to rest; it, without the assistance of some Extrinsick Agent to put it's Parts in Motion, must consequently affect our Sensory with a greater degree of Coldness, than Air or Water, whose Parts are more Agitated.

Earth the Summum Prigidum.

4. And if those that argue for the Earth's being the Primum Frigidum, had only urged that it was the Summum Frigidum, I could have more easily agreed with them: Since, in the Straits of Weigats, the Seas are froze; but not in the Northern Seas, nor that of Taxay; for the main Seas never freeze, but only near the Land, where it is much Colder than in the Ocean.

Water not the Primum Frigidum.

e. It is the Opinion of Ariffotle, and the Schools, That Water is the Primum Frigidum; but in all Waters that are Froze by Cold we always fee, they begin at the top, where the Air is Contiguous; which argues the Air Colder than the Water fince it congeals it: Whereas if Water was the Coldest Body, it ought always Naturally to be Froze, or to begin to freeze, rather in the middle than at the top, and rather in the main Ocean than in Gulfs, Straits and small Rivers: For it is observed, That those vast heaps of Ice that float in the Sea, and which we have so often mention'd, depend not on the Penetration of Cold to that depth they sometime fink to; but vast pieces of Ice being gathered together from the shore and small Rivers, and cemented together, depress each other by their own weight; upon Called A Language Weather which which, the falling Snow, gradually increases their Bulk.

6. But tho' I am far from taking Water to be the Primum Frigidum; yet I cannot agree with Gaffendus, who thinks it indifferent as to Heat and Cold: For except where some adventitious cause Concurs, the Parts of Water being less Agitated than the Humors about our Senfory, by it, we must adjudge it Cold. And tho' by the Heat of the Sun the Inperficial Parts of the Water are a little warmer; yet all Dithe depth of a few Fathoms, Besides it is obferv'd in warm Regions to be much warmer at Land than Sea, and those Countries that Ive near the Sea are generally cooler. But as Cold as it is there, they don't find, That it is able to congeal the Water, tho' at the top it is often Froze.

7. By the Stoicks and many of the modern dir not the Primum Philosophers, the Air is looked upon to be the Prigidian Primum Frigidum. Yet confidering how great a Part of it lies under the Torrid Zone, and that it is for the most Part very Hot, and likewife, that Water enclosed in a Mixture of Snow and Salt will freeze at the bottom and not where it is contiguous to the Air; I fay, considering these things, it will appear, That the Air is so far from being the Primum Frigidum, That it is not the Summum Frigidum. Besides Air condensed to the utmost degree it was possible by the Coldness of the Air; and thut up in a convenient Glass, hath been condensed further by the Application of other Bodies: Whence it appears, that the Coldness

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of the Air depends on the Mixture of some frigorifickCorpuscles with it, and not on the Specifick Texture of it's own Parts, Belides, Water may be Froze when inclosed in Substances not apt to freeze, and when the Air is not Contiguous to it.

Nitre Efficient of Cold

8. The next Opinion I shall consider is, the Grand That of the learned Gaffendus, who ascribes the frigorifick Virtue of Bodies to the admixture of Nitre : But tho' I allow Nitre to be a fubstance dispersed through most Bodies; yet, fince Cold is only a Privative Quality and an abfence of Heat; there are other Agents, which, by stopping the motion of the Insensible Parts of a Body, may deprive it of it's power of Heating. Besides, it must be a prodigious Quantity of Nitre. That would be able to render every Part of the Sca fo Cold as it is found to be; rot to mention. That Nitre is scarce ever found fo deep in the Earth as some Seas extend; besides the Seas afford us very little Salt-Petre, but a great deal of common Salt.

9. And tho' Gaffendus afferts, That Bodies receive the Impressions of Cold, from Nitrous Exhalitions swimming in the Air; yet amongst all the Experiments I have made, to refolve Nitre into Vapours, I have not found, that it was able to effect more in the Production of Cold, than other Saline Bodies. And Spirit of Nitre is so far from having an actual Coldness greater than other Bodies, That it is potentially Hot. And whether the Exhalations of Nitre will congeal Water or not; Spirit of Nitre, I have observ'd, will disfolve 'Ice, as foon almost as Spirit of Wine:

And



And the' Nitre mix'd with Snow or Ice may promote Congelation; yet it proves not that the Parts of Nitre are frigorifick; fince the Experiment will succeed with Spirit of Wine.

10. Having faid, thus much of Gaffendus his Opinion, we shall in the next place, propose fome Experiments; which will be a further Confirmation of what we have been fav-

ing.

- 11. Rock-Petre and Ice, being put into a Bottle, congeal'd the Vapours on the outlide; but pieces of Salt-Petre laid upon Plates of Ice dissolv'd it. Water being satiated with Salt-Petre, and exposed to the Cold in a Bottle, broke it; feveral Chrystals of Salt-Petre having shot in the Bottom of it. From these Experiments it appears, That there are Colder Bodies than Salt-Petre, and that it dissolves Ice. and it is rather Hot than Cold in respect of Ice.
- 12. On a windy and a cloudy Day, having suspended a Weather-Glass in Water satiated with Salt-Petre we observ'd, That when it had flood a confiderable time, and was raifed by the firing up into the Air, the Liquor contained in it was raifed about 2 divisions; and being again immersed in the solution of Nitre, it was presently raised; so that the Air was Colder, than the folution of Nitre.

13. But to conclude this Title; tho' I am far from thinking Nitre to be the Summum Frigidum; yet I doubt not, but that Parts of it riing from the Earth in the form of Vapours, may contribute to the refrigeration of the Air. Not but that there are several other Bodies in

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the Bowels of the Earth, whose Efficie being mix'd with the Air and dispersed through it. may cool the Air according to their Proportions, as much as Nitre: Besides, since common. Salt co-operates with Snow in the Production of Ice as well as Salt-Petre, and according to Democritus, hath Parts of a Cubical figure, which he affigns to Cold Atoms: And fince Gaffendu observes, That Salt-Petre consists of Parts not altogether fo apt for the production of Cold; these Figures being not Pyramidal but Prismatical; I fay, fince these Circumstances all concur. I fee no reason, why common Salt may not be numbred amongst those Bodies, that are apt to produce Cold.

14. Nay, fometimes it may happen, That more violent degrees of Cold may be caused by a like Coalition of feveral forts of Salts. So the Coldness of Snow is advanced by a Mixture of Nitre or common Salt, or other appropriated Additaments. But I must confels. That it is a doubt with me, whether Cold depends on any fuch faline Exhalations, or the Effects of frigorifick Atoms; but to pass by this Scruple at present without any further Notice: I shall add, that what I have said upon this Title is not so much to confute what Opinions I have mention'd, as to shew, that they

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are Doubtful.

One Particular referrable to the XVII. Title.

I am told by the Russian Emperor's Physician, That in the Northern Province of Russia; the Earth is thaw'd but the depth of two foot, and yet good Corn grows upon it.

TITLE XVIII.

Experiment and Observations touching the Coldness and Temperature of the Air.

THO' Gaffendus and feveral others af-per of the fert, That the Air is Indifferent as to Air. Cold and Heat; yet fince Cold is only a Relative Quality, and fince the Parts of the Air. are of themselves in a less degree of Agitation, than the Humors about our Senfory; I fee no reason why it should not be esteemed Cold : For notwithstanding it may acquire a considerable degree of Heat by the adventitious Effects of the Sun-Beams, or fire; yet we fee, that it naturally tends to coolness it self again. And as for the Coldness of the Air, tho' I deny not but that frigorifick Atoms may be mixed with it; yet I judge them not absolutely or altogether requifite to the Production of Cold; fince a bare Diminution of the motion of it's Parts, is sufficient to produce such a Quality in higher or more remis degrees.

2. But the Principal intent of this Section being to produce Experiments and Observations;

I shall begin with the former. A sealed Weather-Glass with Spirit of Wine in it, being enclosed in a Cylindrical Receiver, when the Air in the Receiver was exhausted, it subsided the length of a Barly-corn; but rose again when the Air was let in again; which Esfects I attributed to the Expansion of the Included Air, when the External was drawn out. When the Air was drawn out of the Receiver, hot Bodies Externally applyed, affected not the Weather-Glass; but when the Air was let in again they caused

the Spirit to rife fenfibly.

a. To measure the Condensation of the Air by Cold, we made the following Experiments. And, First we enclosed Air in Weather-glasses hermetically sealed; which, when it was artiscially or naturally refrigerated, and the Aper of the Weather-glass broke open, we could not discern, by the Water it received, that it was condensed above a 30th Part of it's former dimensions. A Glass-egg being inverted into Salt Water, in a Cold Night, the Air was fo far condensed in it, That the Water rose five Inches in the Stem. And Jan. 29 the Air extended into 2057 Spaces was in a frosty Night contracted to 1965 Spaces. So that the greatelt degree of Condensation we could observe was a 22 Part and a little above a third. But a Mixture of Snow and Salt being applied to the Elliptical Part of the Glass, the Water rose 4 laches higher than in the former Experiment; and the Air was contracted from 1965 Spaces to 1800; fo that the Arcificial Cold contracted is more in respect of the Contraction, which the patural Cold produced, than That Condensation

was in Proportion to it's natural temper or rather a moderate degree of Coldness.

4. But to proceed to Observations: Cold may hinder the Operation of the Sun upon the Air in the middle of Summer; and I am told, That it hath been observed to Snow in Greenland all Mid-summer Night, and in the Northern Parts of Muscovy it hath been observed, That severe Frosts happened in the close of August. And surther, Capt. Weymouth says, That in the midst of Summer, when they sailed not near the Latitude of Nova Zembla, their very sails and Tackling were froze: To which we shall add, that the English when they were sailing to Cherry-Island, which lyes betwixt 74 and 75 degrees Latitude; in July it froze so hard, that the Ice hung upon their Cloaths.

5. As for the degrees of Cold in the Air, Dr. Fletcher tells us, that in Rullia, if they go out of a warm Room into the Cold, it makes them Breath with difficulty. It is observed at Moscow, That Water thrown up into the Air falls down congealed, the Air is so Cold; and at Smolensko in Rullia, the Spittle freezes before it can fall from one's Mouth to the Ground.

6. I have observed the Air grows sensibly heavier, in frosty Weather; but whether it depends on any frigoristick Atoms dispersed through the Air, or not, I shall leave to be decided by further Tryals. In Northern Countries it is observed, That foggy Weather presently vanishes when Frost begins; the moist Vapours being, by that, condensed and precipitated, and the Surface of the Earth so closed up, that other Vapours were repressed, and kept from rising;

and the Air hath been by feveral observed a have been much more clear in the Winter, here in England, and Sweedland, and elsewhere, the

at other times.

7. The Refraction of Luminaries in the Northern Air in Nova Zembla is so great, that the Dutch-Men observ'd the Sun to appear to them 14 Days sooner than it ought to have done. And Capt, James tells us, That he observ'd the Lattude of Charlton-Island to vary 52 Minutes, and the Sun to rise 20 Minutes sooner than it ought to rise: Besides several Instances of Refraction, laid down in the History of the Air.

8- To what we have faid, of the Coldness of the Air; we shall subjoyn the Relations and Observations of Navigators, which we shall either propose as promiscuous, or in Confirmation of the three following Observations

ons.

i. That the greater or leffer Coldness of the Air in several Climates and Countries, is nothing near so regularly proportionate to their Respective distances, from the Pole or their Vicinity to the Equator as Men are wont to presume. It hath been observ'd, That of Places of an equal distance from the Northern and Southern Poles, those near the latter are Colder. Tho' in Moscow, the Cold is almost intolerable; yet in Edenburgh, which is a degree more Northwards, the Air is temperate enough, and the Snow feldom lies on the Ground. Mr. Pool in his Northern Voyage tells us, That it did not freeze near fo hard near the 70th degree as in the 73d. And tho' Nova Zembla, lies near 4, 5 and 6 degrees more Southerly from the Pole than Greenland land, yet the latter hath Grafs and Trees and fuch Beafts as feed upon them; whereas in Nova Zembla there is no Grass and only such Beafts as feed on Flesh. To which I shall add, That Josephus Acosta tells us, That under the Line, when the Sun was in the Zenith and just entred into Aries, in March, he felt himfelf very Cold; and he likewise tells us, That under the Burning Zone in Quitto and the Plains of Peru the Air is temperate; at Potofi very Cold; and in Ethiopia, Brafile and the Moluctoes very Hot. And he observes further, That Snow lyes on the tops of the Hills, and that it is extremely Cold, when the Sun is for their Zenith under the Line. Mr. Hudson in his Voyage hath observed. That one Day, they were much disturbed with Ice; and that the next Day, it was very Hot: And we are further informed by Acosta, That tho' the Seas of Mozambigus and Ormus in the East, and Panama in the West, are very Hot; yet that of Peru of the same height is very Cold. And Capt. James's Observes, That the Charlton-Island is Colder than Nova Zembla, yet is it of the same Latitude with Cambridge. To which I shall subjoyn, That an English Navigator tells us, That tho' Pustozera in Russia is 68; degrees, yet it is well inhabited, and a Town of great Trade. And in Hudson's Voyage it was observed, that beyond 80 degrees they found it moderately warm.

2. The next Observation is, That the degree both of Heat and Cold in the Air may be much greater in the same Climate, and the same Place.

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at several seasons of the year, or even at several times of the same Day, than most Men would believe.

In Proof of this Proposition we shall produce the following Testimonies of Travellers and of Navigators. And, 1. That there is a great variety Weather in Russia, Dr. Fletcher witnesses, who observes, that the all Winter the Ground is covered with Snow and the Fields frozen up; yet the Fields in the Summer are covered with slowers and filled with the delightful noise of Birds; and then the Weather is as much too Hot, as it was before Cold; June, July and August being warmer than the Summer in England: And the like is confirmed by the Observations of others, amongst whom Observations of others, amongst whom Observations of the Summer in England: And the like is confirmed by the Observations of others, amongst whom Observations of the Summer in England: And the like is confirmed by the Observations of others, amongst whom Observations of the Summer in England: And the like is confirmed by the Observations of others, amongst whom Observations of the Summer in England: And the like is confirmed by the Observations of others, amongst whom Observations of the Summer in England: And the like is confirmed by the Observations of the Summer in England: And the like is confirmed by the Observations of the Summer in England: And the like is confirmed by the Observations of the Summer in England: And the Summe

And at Pequin, the Royal City of China, tho' it is but 42 degrees Latitude; yet in the Winter, Martinius the Jesuit tells, us it is a hard frost for four Months together, so that all the Rivers are froze up. And Prosper Alpinus tells us, that Grand Cairo, which is only 6 degrees from the Tropick of Cancer, tho' the Summers are insupportably Hot; yet the W inters' are considerably Cold : And one thing he there takes notice of is. That in that Place they are feldom or never troubled with Distillations or Rheums. And Purchase tells us, That in Greenland one Day will be extremely Cold and the next as violent Hot; fo that at Mid-night Tobacco may be lighted at the Sun-beams, by the help of a Glass: To which Relations I shall add, That Capt. James tells us, That in CharltonIlland, the the Winter was excessive Cold; yet in June it was so. Hot, with Thunder and Lightning, That the Men were forced to go a shore

to cool themselves in the Water.

Alpinus tells us likewise, that in Agypt the Air is some part of the Day extremely Hot and at other times very temperate and cool. And O-learius tells us, That travelling over Mount Tauru in Persia; the it was too Hot in the Day i them to proceed in their Journey, yet at Night they were so benummed with the Cold, That they were scarce able to light off their Horses; and the same Traveller observed at Fallu in Persia both Lightning and Thunder, Winds, Snow, Rain and Ice, in one Night. And in Charlton-Illand the the Heat of the Sun in June be insupportable in the Day; yet at Night, the Cold is strong enough to freeze Water, in Vessels, an Inch thick.

3. The third Observation is, That in many, Places the Temperature of the Air, as to Cold and Heat, seems not to depend so much on the Elevation of the Pole, as upon the Nature and Circum-

flances of the Winds that Blow there.

It is commonly known, That in this Part of the World, Northerly and North-easterly Winds are accompained with Cold, and in Winter with Frost: But I once observed here in England a South-Wind when it froze hard; and Capt. James in his Voyage hath observed the like: And Prosper Alpinus observes in E-sypt, That the North-Winds are extraordinary cooling; and that upon the Blowing of the Etesian Winds the Plague ceases, at Grand Gairo.

That

That this cooling Quality depends on the changes it receives from the Places it pales over, is highly probable, as well as that it acquires other Qualities the like way. Acols Lib. 2. Cap. o. Takes notice of Winds. The in some Parts of the Indies, so corrode Irongates. That they will crumble away in one Fingers. And the same Author tells us, That tho' in Spain an Eafterly-wind is Hot and troubles one; yet in Murria, it is Cold and healthful; but in Carthagena not far from the former Place, it is troublesome and unhealthful. The Meridional (which they of the Ocean call South, and those of the Mediterranean Sea. Mezzo Giorno) is commonly Kainy and Boyfterous; and in the fame City, I speak of, it is wholesome and pleasant. And in Peru, he fars, the South and South-west-winds are very pleafing.

How the Winds come by these Qualities! fhall not now dispute; but to give some light into the matter I shall propose the following

Experiment.

Setting a Weather-Glass with a flat Bass apon a Board, and Blowing several times upon it with a large pair of Bellows, tho' the Air semed Cold to my Hand; yet the Pendulous drop ascended a little, the Air being a little heard in the Bellows: But if the Clack of the Bellows was so fastned, That the Air must wholly enter in at the Nose of it; the stream of Air, which was by that means drawn toward the Weather-Glass from the Window, being cooler, would cause the Bubble to subside.

Bat

But having provided fuch a Tile as they lay on the ridges of Houses and filled the hollow side with Mixture of Snow and Salt, and Part of that Mixture being placed about the Bellows ; I found, That the Air blown upon my Hand was, by that means, highly refrigerated : And this Air being blown upon the Ball of a common Weather-Glass, the Water manifestly ascended; but fublided again, when we left off blowing. But to profecute the Tryal, we drew back the Nose of the Bellows, and upon that, the Wind blowing along that Cavity upon the Weather-Glass, manifested a higher degree of Cold-

But tho' it from hence appears, That frigorifick Atoms may refrigerate the Air; yet I believe not, that all Winds must necessarily be cooled fo; fince the Cold Air near the Poles fwimming upon that which fills the lower Part of the Atmosphere, may, for want of a Reflection on of the Sun-Beams, be fo Cold, as to cool the Air suddenly, when by the falling of Rain it is beat down upon us : For Acofta hath observ'd. upon Mountains higher than the Alps, That the Air was extremely Cold. And the Hollanders who failed within 17 degrees of the Pole observ'd, That their Gold Winds were chiefly Northerly and North-easterly. But,

To conclude this Title, I shall add an instance or two to shew, That Cold Winds receive not fo much their Qualities from the Quarters from whence they Blow, as from the Regions over which they pass. For Mr. Wood tells us, That tho' in England the most troublesome and unwholesome Winds

came

came from the Sea; yet in New-England those are the most wholesome: Because the Northeast-wind coming from the Sea thaws the Ice and melts the Snow; but the North-west-wind coming over the Land causes Cold. And Capt. James observed the like in Charlton-Island, viz. That the South-wind was Coldest which came over a frozen Tract of Land.

Particulars referrable to the XVIII Title.

1. The little sealed Weather-Glass being immersed in Water, contained in a Glass-Vial greased in the inside, when the Water was froze, and the Ball of the Weather-Glass was incrustated, being taken out, the Ice was broke off: Upon which the Tinged Liquor immediately rose in the shank of the Weather-Glass; but presently subsided again below the former Mark; from whence it appears, That the Air may communicate a greater degree of Cold than Ice it self.

2. Having placed a Weather-Glass, made by the Standard at Gresham-College, in a Cellar, where Beer continued unfroze in a very sharp Winter; last Night and this Morning the Tinged Liquor stood 2 Divisions and 4 above the freezing Mark; but being removed into the Garden, it subsided to the freezing Mark: But tho' the Cellar was warmer than the Air; yet it was not so warm as my Chamber; the Weather-Glass there standing two Inches above the freezing Mark, in the Morning before the fire was made; and in the Summer the Tinged Spirit

Spirit ascended to the 8th oth and sometimes

almost to the tenth Mark.

3. The last Night being rendered very Cold by Snow, Frost and Wind; this Morning, the Weather-Glass being removed into the Garden, the Tinged Spirit subsided two Divisions below the freezing Mark : Yet the Cellar did not become fo much Hotter, by an 'Arnmeisans; but that Oyl of Aniseeds continued undissolv'd in it till , the next Morning, tho' the moderate warmth of Spring or Autumn is sufficient to keep it fluid.

+ A Weather-Glass being held in the Stream of Water as it came reaking Hot out of the Pump, the Liquor subsided considerably; and being carried to my Chamber, the Air there being Colder than the Water, it was depressed

lower.

g. Having held a Weather-Glass in the reaking stream of Pump-Water, the Spirit rose about 5 Inches higher than it did at a Well in Oxford; and being in some measure immerfed in a Spring that usually smoaks in the Winter, it was raised a little higher. And the Weather-Glass being placed on the North fide of the House about Noon, I found that the temper of the Air then, was much the same with the temper of the fmoaking Spring.

6. Feb. 19. The Frost having continued 3 Days, the Spirit was raised as high, by the warmth of the Spring as it used to be. The next Day the Spring beginning to smoak, the warmth of the Water raised the Spirit near a quarter of an Inch higher than it used to rise at the

A Training they obligated

Spring-head some Months ago. And the Water was then much warmer than the Air, for the Spirit when brought to my Chamber fublided: the Ground without being covered with a lice tle Snow

7. A Gentleman told me, That he had ohferv'd the Tinged Spirit fometimes higher, when it was frosty, than when it was not, And he further told me, That the Weather-Glass being left in Water till it was froze. when it was cleared of the Ice and exposed to the Air, the Spirit manifesty subsided. The fize of the Ball of this Weather-Glass was as big as that of a large Crab, and the Stem was about 2 foot and I long. And the distance betwixt the station which the Spirit rested at in the Water and the Air was above three Inches.

A Relation given me by an Ingenious Gentleman lately returned out of Poland.

I. In frosty clear Weather, he observ'd the Sun and two Parbelions one Eastward and the other Westward; betwixt ten and twelve a Clock; and when the Sun-shine appeared it was full of glit-

tering Particles of Ice.

2. A Dutch and a Scotch Ship having failed beyond Greenland, within one degree of the Pole, they observed. That tho' there were vast Regions of Ice near the shores; yet near the Pole, the Sea was open and free enough. From the North-East they observ'd, That there came a great rolling See, not unlike the Spanish Seas : And that the Cold was no violenter than that in Greenland. And further they observ'd,

That

That failing from Greenland, the Compass first varied a Point and then two, and when they came near the Pole, the Compass varied 4 Points, and that towards the East.

The Captain likewise told me, That they are troubled at Sea, sometimes with thick Fogs, some of which last half a Day, others a Day; and

others a whole Day.

And he likewise told me, That lying at Anchor near Bellsound on the coast of Greenland, near a very high Rock, he and some others got to the top of it; which they judged to be half a Mile high: And when they came there; they found the Weather clear and the Sky serene, and so Hot that they were forced to strip themselves: But below they could discern a thick fogg; which when they came down, they found was very Cold, and Dark.

A Passage taken out of the Czars-Doctor's Letter.

- 1. At Vologda in the North-East from Moscon we found the Cold Weather in December not to last 3 Days; but the Rain was unusual and dangerous. And for 30 years past the Winters have been so moderate, That People are not froze on the Roads in several Postures; but sometimes they lose their Noses, and have their Faces froze.
- 2. The Warmer the Room is in the Day, the thicker the Hoar is at Night upon the Glass; being sometimes an Inch thick: And if it be a small Frost, The Nails of the Windows and Doors will be tipped with Frost. The Falconers for That the Birds creep under the Saow at Nights

Of the

Nights. Bears make themselves Caves against Winter, and I remember I kept one two Days without meat or drink; he in the mean time, making a Lather with his Tongue and sucking his Paws.

3. A Wind from the Sea causes a Thaw as well as at Archangel. The Air is so healthful they use very little Physick, so that the Poor-

er fort live 80 or 100 years old.

TITLE XIX. Of the strange Effects of Cold

HE Quich tell us, That they found it to Cold in Nova Zembla that when their Sheets were washed and hung to dry by a fire, one fide would freeze as the other thiwed; and that they themselves were so Cold, That they could not warm themselves by the fire; for they usually smelt their stockings burn, before they were sensible of the Heat. And Capt. James tells us, That in Charlton-Island, the one fide of Water in a Vessel troze, whilk the other was next the fire. To these Relations I shall add, That Marcus Polus was told, That on a Plain, which was betwixt two of the highest Hills in the World; fire would neither burn fo briskly, nor boil things fo effectvally as in other Places; which I am the more unwilling to reject as impossible; Because it Show and Ice owe their Coldness to something which reigns in the Air. Nature may make

the Air as Cold in any other Northern Climates; Saline Expirations being every where difperfed through the Earth and Ses. And this Cold is so violent, that Water being poured on a fool and a Tankard placed upon it; by a Mixture of Snow and Salt, the Tankard will be fo frozen to the stool, That the one being lift up, raifes the other along with it,

2. Gerat de Veer, fays, That if they put a Nail into their Mouth it would be froze, and bring Blood along with it when taken away. And Dr. Fletcher tells us, That in Muscowy, if one hold a Pot in ones Hand ; being froze to it, it will pull off the skin at Parting. And in Nova Zembla, it hath been observed to be so Cold. That it froze Salt Water two Inches thick.

2. In the Market-Place at Moscow, Olearius tells us. That the extreme Cold caused a Clift a foot broad and feveral Inches long; and that confiderable Clifts will be made by the Cold, I am inform'd by others ! And the Dutth in Nova Zembla acquaint us, That the Ground was to froze that they were not able to

thaw it by burning Wood upon it.

after then Caugares

As for the Effects of Gold on compound Bodies &c. That it will freeze Beer, Ale, Vinegar, Oyl, common Wine, and even Sack and Alicant we have already shewn; and that it hath confiderable Effects on Wood, Bricks, Stone, Vellels of Glas, Earth, and even Pewter and Iron themselves. To which I shall add, That the Cold preferves some Plants; yet an excellive degree of it destroys them.

Cold when at the highest degree insupportable; and Oleanan acquaints us, that fometimes the Cold in Muscopy is so excessive, That neither motion nor Cloaths refift the ill Effects of it: but in Moscow the Air is very good and healthly. the Plague very feldom happening there. And Dr. Fleteber tells us, That in Ruffia it is fo Cold fometimes, That People fall Dead in the Streets, and that the Bears and Wolves invade and Plunder the Towns in whole Troops. And the Effects of Cold have been found fo frange sometimes. That it hath cansed Blifters to rife, not only upon the Hands and Face but their Arms and Legs : Belides thefe Instances, Capt. James tells us. That their Cloaths would be covered over with Frost and Iceicles would fo hang to their Hair, That he was forced to have his Head and Face, that they might have nothing to hang at. And Purchas fays, That their very shoes would be covered over with a Hoar-Frost on the inside, so that they were not able to wear them. And I am told, That an Army of 40000 of the Turks all perished at once by excellive Cold. I am also infor m'd, That a Brovince of Poland, of the fame height of the Pole with Normandy, is subject to some fort of Golds, which occasion a peculiar kind of Sickness and at other times Death. And Cancerous Sores are as fatal as those caused by Hot corroding Humours ; and those that dye of the Cold, either are seized with a drowzinels and Goldnels of the Extreme Parts, and dye in a fleep, or having their Guts and Reins first froze and then Gangreed and Mortified, vomit every thing they take, and then languish with violent pain and Dye; and their Bodies being opened, their Guts are black, and as if it were glewed to-

gether.

6. What effects Cold hath upon other Animals, hath not been much observed by Authors: But a French Author tells us, That the Cold in Okrain as the Polanders call it, is sometimes so great, That it destroys Horses and some other tame Beasts. And the same Author mentions a sour-stooted Creature, called Boback, peculiar to that Province, one of which being dug out of the Ground where he was froze, (for they usually hide themselves there in the Winter) when they were about to see him, the sense of Pain recovered him; and this was presented to a Polish Lord from whom I had the Relation.

7. It is reported, That in the Northern Countries, the Birds and wild Beafts are ninally turned white: But the' I don't wholly reject it as false; yet I cannot believe it univerfally true. But this is certain, That good Authors mention, white Bears and Foxes in Nova Zembla, and white Partridges upon the Snowy Alps; and I have heard of white Pheafants in Savoy. What may be the Reason of this Colour I shall not dispute, nor shall I determine, whether it be caused by any feminal impressions, or the Imagination of the Females, who have Snow always as an Object before them: But that all Beafts and Fowls in the Northern Climates are of that white colour I find is a Mistake; for I have feen Deers skins brought from Green-

land

land of a Dun colour. Yet one thing which is very firange is, That in Greenland and Livonia Hares become white in the Winter, and return to their Natural colour again in the Summer. And Capt. James tells us, of Foxes in Greenland which are pied black and white.

Particulars referrable to the XIX Title.

z. Lieutenant G. Drummon told me, That at Smolensco, the Barrels of Beer, being frozen a considerable thickness; the Liquor contained

within was much fronger.

2. Two Smedish Ambassadors confirmed to me, That the Hares in Muscory, change from their Natural colour to white in the Winter, and recover their own colour in the Summer; and that on one side the River Duna which separates Lavonia and Muscory, the Hares are white, and

on the other fide of ordinary colours.

3. It is observed in Russia, That if a Man, touches his Tongue with the Metalline Head of a Cane, it freezes his tongue immediately; so that he cannot separate it without much Pain: For the Parts of the Metal being at rest, and the Spittle whose Parts are in a weak Motion, striking against the Metalline Body, are wholly deprived of it, and consequently freeze, so in a Billiard-Table one Bowl in Motion striking against another not in Motion, communicates as much of it's Motion as it can to the other, and loses it's own; and so the Vapours and steams in a Room, in frosty Weather striking against the Glass-Windows, are deprived

prived of their Motion and froze, which is obferv'd to be much thicker upon the Glass in Russes than here in England.

A Note out of Martinius in bis account of China.

This Author tells us, That at Peking, tho' the Pole be not elevated above 42 degrees; yet for four Months together, from the middle of November, the Rivers are froze in one Day, fo that they bear Coaches and Hor-fes.

A Note taken out of Martinius Cromerus bis Polonia.

The Cold is fo violent in these Countries sometimes, That the Trees wither at the Roots, and Water is froze as it falls through the Air; and the Waters are froze up for two Months, so that they bear Horses loaden, and Coaches. And this Author tells us, That he passed over the Weisell in Massovia with a Coach and Horses, and other Horse-Men. And in Prussia the Fishing in the Ice began after the beginning of November, and lasted till March was ended.

Another Note out of the same.

1. They catch Fish more commodiously in Winter than Summer; for breaking holes in several Places in the Ice, a Net being cast into one of them, and ropes fastned to it, Men with Poles

Poles, and Horfes, draw the Net from one Place

2. I am told that at Warfaw, in twelve Hours the Water was froze 4 Inches downwards. One that failed to make Discoveries beyond the Archick Circle, told me, He could eat as much in one Day, as in ten here; and that after they had failed over a deep blew Sea, they came to one as black as Ink, which being sounded, it was above 70 Fathom. Sack being froze, and thaw-

ed again, presently lost its Vigour.

3. In these Parts the Frost penetrates the Ground five Foot; and the Ice in Iberia in the River Ob, is said to be a Fathom and a half thick; there being there but twelve Weeks in the whole Year without Frost? The Rivers have breathing places a Mile long, out of which Fumes ascend, as out of a Cellar, when the Door is open'd. Death by Cold is not painful, if it be intense. Cold dries excessively, cleaves the Earth, and causes Timber to crack.

TITLE XX.

Experiments concerning the Weight of Bodies frozen and unfrozen.

The Weight 1.
of Bodies
frozen und
unfrozen. Ot

To try whether Bodies upon freezing would grow heavier, fince Epicurus and other Atomifts, fuppose Congelation to depend upon the crowding in of frigorisick Atoms; we exposed Eggs to be froze all Night, and in the Morning we found they had lost four Grains of their Weight, which we suspected to proceed from

from the Avolition of some Exhalations through the Shell; since at other times we observed, That Eggs counterpoised lost eight Grains of their Weight, in some process of Time.

2. Water froze and weighed, counterpois'd a Grain and a little more, than when it was thawed: But the Experiment being made in a Glass with a long Stem, hermetically seal'd when the Water was froze; it was as heavy or heavier after it was thawed; and the same Equality of Weight betwixt frozen and unfrozen

Water, happened in other Experiments.

3. Stones being weighed after exposed to the cold Air, and also in a warm Air, they seemed to discover an Increase of Weight; but I suspected it proceeded from Water imbibed into their Pores, since Stones are observed to increase their Weight in Water: And further, because one that was well polished, and not apt to imbibe Water, retain'd barely its own Weight. So that the Doctrine of the Epicurean Freezing, must be invalid, except he supposes the frigorifick Atoms, like those of a Load-stone, to be without Weight.

An Appendix to the XX Title.

The fore-going Experiments, may not only fatisfie us, That the Doctrine of the Epicureans is erroneous, but may likewise fielp us to correct some extravagant Relations, on the other Hand: For Helmont tells us, That Water thawed in a Vessel Hermetically sealed, was & heavier than before. But perhaps this Difference might in part depend on the Access of Vapors

on the outlide the Glafs. In opposition to what Manalobus tells us, I found, That Water froze in a Metalline Porringer, in one Experiment loft to, in another 60 Grains of its Weight; which lattributed to an Avolition of some Parts of the Water, fince when we order'd the Matter fo, that no Water could steam out, there was no confiderable Increase or Decrease in the Weight of Water froze or thawed.

Particulars referrable to the XX Title.

1. Quick-filver being weighed in the Air, and afterwards counterpoised in Water, when by the application of a Mixture of Snow and Salt it began to freeze; the Bubble weighed of a Grain less than before. A Globe of Snow rammed into a Mould, whose Diameter was an Inch, weighed 112 Grains. A Globe of Ice of the fame Diameter weighed, 2 Drams, and 5 Grains.

2. After a long Frost and Snow, the Liquor, in the gaged Weather-glass stood below the first Mark; but the Mercury in the Baroscope stood at near & below 29 Inches; which perhaps might

be attributed to the high Wind.

3. Four Ounces of Snow being counterpoiled were exposed to the Frost all Night, and at 10 of it in the Morning, had loft near 30 Grains; which Parts feemed to have been evaporated; the melted Liquor in the Bottom of the Scale amounting to no more than 8 Grains.

Two Ounces of Snow depressed flat, so as to form a large Superficies, and counterpoiled, in a Night's time loft 59 Grains; no Water be-

ma



ing found in the Scale; and two Hours after, the Decrement was 63 Grains, none of the Snow appearing yet to be melted.

TITLE XXI.

Promiscuous Experiments and Observations concerning Cold.

1. SEveral Flowers being gathered in Decem- Whether Frost hinder ber and January, and hastily smelled to odoriferous had no fensible effect on the Sensory, which Effavia Phænomenon I attributed to the Frost, hindring from exerting a sufficient Quantity of Spirituous Sap from ri Power. fing up into them; and not that it prevented those spirituous Parts from emitting Effluvia; fince a vigorous fresh Primrose, had an Odour genuine and fweet.

2. Rose-water being froze, when it was wholly Ice, afforded a genuine Scent, but something fainter, than when it was thawed again; but in making these Experiments it is requisite, that the Body smelt at, should not be held too long near the Nofe, lest the warmth of one's Face should help to excite those Odoriferous Parts,

and consequently frustrate the Tryal.

3. Stinking Water being exposed to the Cold

and froze, was altogether inodorous.

4. It is reported by feveral, and attefted by Olearius, That the Russians and Livonians, enable themselves to bear Cold extremely, by going out of their Store naked, immediately into cold Water, and even Ice it felf.

5. Having made use of a good burning-Glass to concentre the Rays of the Moon, I could neither perceive them cold or hot; the Sandorius tells us, That they are hot, and that being concentred, and cast upon the Ball of a common Weather-glass, the Water was sensibly depressed; but since my Glass, for as much as I can gather from the Narrative, was better than his, I must suspend my Assent; 'till further satisfied by Experience; for since he tells us, that several of his Scholars stood by to watch the Event, the Effect might in a great measure depend on the Warmth of their Breath.

One Particular referrable to the XXI Title.

The Samojedes cloath themselves with Rener Skins, the Hair being outward; and I have found a Pair of Cangies warmer than surred Gloves. They are chiefly made use of for the Sledge, tho' one may walk in the Snow with them, it being so dry, that a Scarlet being covered all over with it, it will brush off without wetting or endammaging it.

To the XI Title.

The force of 1. The Barrel of a Gun which was about a Expansion Foot long, and of a proportionable Diameter, had the Touch-hole riveted up, and a Screw fitted to the Nose of the Barrel, which being done, it was filled full of Water, and suspended in a Perpendicular Line: The Screw having been thrust down as forcibly as a Man could; in a frosty Night, the congealed Ice raised the Screw confi-

confiderably, so that Ice had made it's way out at the fides of the Barrel : But the Experiment being repeated, and the Intervals of the Screw filled up with melted Bees-wax, the expanded Ice not being able to raise it, the Nose of the Barrel was cracked obliquely; besides several other Flaws in other Places, which gave way to the Wind blown into the Barrel to try it.

An Appendix to the XVII Title.

Bartholinus citeing an Experiment, wherein of the Ef-the Proportion betwixt Nitre and Water was feels of Ni-tre in free-35 to 100; to try the fuccess of it, we mixed a zing. Pound of Salt-Petre with a Pounds of Water, and stirring it about constantly, as Cabaus directs, in an Hour and half we perceived not the least Ice; whereas, according to him, it ought to have been wholly froze in less time; but we could not perceive the Vapours on the outfide of the Glass in the least froze.

For a further Tryal, we mixed two Ounces of Salt-Petre with fix of Water in a Glass-Vial, but by all the shaking we could not produce the least Ice; tho' whilst the Nitre was dissolving the Mixture was fenfibly colder; and the fame we have observ'd to happen upon a Dissolution of Common Salt; tho' the Degree of Cold was not fufficient for Congelation, which I was fatisfyed in, by removing a Thermoscope out of the Mixture of Nitre and Water, into Water which was placed in Snow and Salt: For by that means the Liquor in the Weather-Glass subsided in the latter about 3 Inches; fo that I am apt to think K 2

the

the Learned Cabaus mistook Chrystals of Nitre for Ice.

It is believed by most Water-men, That the Water begins to freeze at the bottom, because they observe large Pieces of Ice rise from the bottom of the Water: But the Truth of it is very reasonably question'd, since we not only fee, that Water in Vessels, but in Wells, begins to freeze at the Top; and feveral Arguments in proof of the contrary may be found in our Section of the Primum frigidum. And as for those Pieces of Ice, which they observe to emerge, that Phanomenon may eafily be folved, without supposing the Water to begin to freez at the Bottom : For fince the Water, which runs along the fides of the Banks being froze, feveral Stones may stick to it; they by their Weight may cause it to subside, when it is partly loofned by the Heat of the Sun, and the Water, by that Rarifaction becomes lighter: Yet, when the Water above is cooled, and the Water below being warmer, hath melted the Ice in some measure, and loofned some of those Stones which were before froze to it; the Ice becoming specifically lighter than the Water, must consequently emerge. On which occasion, I shall here obferve, that Capt. James Hall takes notice, That they found a Stone of three hundred weight upon a Piece of Ice. In confirmation of our Solution of this Phanomenon, I might alledge the Experiments laid down in the Section of the Duration of Ice. And it were to be wished, that for a further Decision of this matter, that either Divers were fent down, or Instruments

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ments, which would bring up Ice if any were there.

We took a feal'd Weather-Glass, and having inverted the Stem of it when furnished with Spirit of Wine, so that, that being placed in a Hole purposely made in a Box, the Ball of the Weather-Glass rested on the Box; about that we placed a Mixture of Snow and Salt, and found, that presently the Spirit of Wine was retracted. So that Liquors may be condensed, without the affiltance of their Gravity, to depress and cause the Parts of the Body to link together: But whether in this case, the Contraction was affifted by the Tenacity of the Liquor or the Springiness of some Elastick Particles, will be inquired into in a more proper Place.

Frogs and Toads being taken up from under Ice, were brisk and lively; and it is observ'd, that in frosty Weather they generally lye in the

Bottom of Pits, for their Security.

Paralipomena to the II and XX Titles, of the frost getting into bard and folid Bodies.

In England it hath been observ'd. That Wood of the Efwhose Diameter, was a Foot through hath been feets of for for froze; and in Poland the Frost hath been so lid Bodiespowerful, that it hath rendred the Timber fo hard, that Hatchers would not cut it; and the Wood with which the Houses were cover'd would give Cracks as lond as Piftols. And I am told by one, that his Bow being froze, it he did not take a great deal of Care in thawing it, it would break. Marle and Chalk will be shattered with the Frost, the Texture of those Bo-K 3

dies being by that means opened and rendered more fit to nourish Plants and Grass. And I am told by an Experienced Mason, that even free stone, of which Houses are built, will crack and flaw in frosty Weather. And it is observed in England, That stones dugg up in the beginning of Summer and seasoned in the Air are not near fo subject to flaw as those that are dug up and worked, whilft the Frost continues. And it is further observed, That both Earthen as well as Glass-Vessels are considerably impaired by the Effects of Frost upon them. To which instances I shall add the Testimony of Maistre Bernard Palissy who fays, That the' the Stones of the Mountain Ardenne are harder than Marble; yet for fear of Frost they are drawn out of the Quarries in the Winter: And he further adds, That in the Winter the Rocks fometimes crack and fall down without being cut. And it hath been observed. That Iron-instruments brought out of the Cold into a warm Room have been covered over with a white Hoar; and it is not only confirmed by foreign Artists but several here, That Cold hath so great an Effect on Steel as to make feveral Pieces of Metal more brittle than in the Summer; so that they are then forced to work them another way and to give them a different temper.

Hot Water does not

It being a Tradition, and also taught by A ristotle, That Hot Water is sooner froze than freeze from Cold; to determine the matter, I made the following Experiments.

Cold

Cold Water being exposed to freeze in one Porringer, boiled Water cooled in another, and Hot Water in a Third, at 8 a Clock; the Cold Water began to freeze at 4 after ten; the Boild Water cooled, at 4 past ten; and the Hot Water at 4 an hour past Eleven. And the like success happened, when the Experiment was tryed a second time in Metalline Vessels: And the Experiment being again tryed with greater exactness, the Cold Water and the rest being exposed to freeze at 4 after 6, the first beganto freeze 4 after 7; the Water heated and cooled again 4 after 7, and the Hot Water was not froze 4 an hour after Eight.

The like Experiment being tryed with Water contained in Glass-Cylinders of an equal Bore sealed at one end, we found that there was very little difference in the time of their Congelation, when immersed in a Mixture of Snow Salt and Water; but once, when the end of one of the Cylinders was drawn smaller than Ordinary, the smallness of the Pipe occasioned the Hot Water to begin to freeze soon-

er than the Cold Water.

Postcript.

Accidentally looking upon the Circulus Pifanus of Berigardus, I found, That the that Author opposes Aristotle in other Points; yet he agrees with Him, That Hot Water cooled, will fooner freeze than ordinary Cold Water; but having tryed the Experiment, I observed, That both being exposed to freeze when by a Weather-Glass I found them of the same temper,

K 4

my Domestick who attended them, took noticealfo that they both began to freeze at one time. And
tho' Berigardus further wonders, That warm
Salt-Water should be less subject to freeze for
being Salt; yet from Experiments already
laid down, it abundantly appears, That tho'
Salt Externally applyed promotes it, yet Internally being dislolv'd in Water, it prevents
Congelation.

Particulars referrable to several Titles.

For a further Confirmation of the VI Title. I shall add that Purchas relates Lib. 4 Cap. 19. That the Samojeds, when they Bury their Dead, only cover them with a Pile of stones, and tho the Dead Bodies may be seen through them; yet the Coldness of the Air preserves them from stinking. And the same Author tells us, That in a certain Island they preserve their Fish and Flesh, by hardening it in the Air, bet-

ter than if it were corned with Salt.

In Confirmation of what hath been delivered under the VII Title, I exposed several Vials filled with Water and unstopped, to be froze, and found that the Bottles were broke in pieces, by the Expansion of the frozen Water; so that the Phænomenon could not be attributed to Nature's abhorrency of a Vacuum: For if either the Expanded Water could have made it's way by stretching the Glass, or leaving the Superficial Ice congealed at first in the Neck, or any other way easier than to break the Vessel; the Vessel would probably be left intire, I say probably, because sometimes in such Experiments

riments something may intervene which requires further Tryals and Observations to discover. Since I have in other Experiments made it appear, That the Water beginning to freeze at the Bottom rose a considerable height in the Stem without breaking the Bottle, and I have sometimes had a good deal of a Liquor froze in a stopped Vial without breaking it, as if the success were varyed by some uncommon Properties in the Glass, or some peculiar softness of the Ice.

In Confirmation of what is delivered in the VII Title, of the Expansion of freezing Water, I shall add, That the Capacity of a large Bottle being filled with Water, except the Neck, and that filled with Oyl, the expanding Water not only elevated the Cork; but raised it several Inches; it being supported by a Cylinder, partly consisting of Oily, and partly of Watry

Particles of Ice.

Children of the White

to be sell incond strap full to

It is a General Tradition amongst Fisher-men, That when Ponds or Rivers are froze up, except several holes are broke up for the Air to communicate with the Water, the Fishes will be suffocated; and Olaus Magnus, tells us, That Fishes are usually found suffocated, when a thaw comes, where Veins of living Water do not enter.

But I am not satisfyed, whether, if the Tradition be true, they may not be killed either by some Subterranced Steams or their own Excrementations Effuvia prevented, by the Ice, from making their way out of the Water; and it may be questioned further, whether this Phænome-

non

non may not be caused, by excessive Cold as

well as for want of Air.

Wherefore to fatisfie my felf, whether the Vulgar Opinion be true or not, I enclosed fome Gudgeons in a large Glass with a long Neck, and having froze the Water in the Neck by applying a Mixture of Snow and Salt, I found. That the Fishes lived a considerable time. And the like I observed, when the same Fishes were contained in an Earthen Vessel with a little Water frozen over: Where the External Air was wholly separated, and prevented from communicating with the Water under the Ice; yet one thing observable was, That there was a large Bubble of Air, under the Ice, which I suppose came from the Fish: For I have obferved, not only these fort of Fish but Lamprels take in Air, and then being immerfed under Water emit Bubbles, both at their Mouths and Gills. Gudgeons frozen up in Ice in a Bafin recovered when it was thawed; but some that continued 3 Days in Ice revived not. Frogs froze in Water till they were all enclosed with Ice, and till one of them was stiff with it, recovered when it was thawed, and Swam about; tho' before some of them lay with their Bellys upwards and void of Motion.

As for the weight of Bodies frozen, Capt. Fames tells us, That Wood, that had lain all Winter under Ice would fink when cast into the Water. And he likewise tells us, That the Ice of Wine is fo durable, that a Butt of Wine which was froze in the Winters conti-

nued unthawed in May.

Purchas tells us, of two pieces of Ice which they found lay fast on the Ground, the one of which



which was 20 fathom under Water and 12 above, and the other 18 fathom below the Surface of the Water and 10 above it.

It is observed by Purchas and several others, That the Snow lying upon the Ground in Ruf-

sia as well as in England makes it fruitful.

It would be worth while to try, what Ef- of the fefects Cold hath upon occult Qualities as well as paration of Liquers by manifest ones; and likewise upon Fermentati. on; fince it is observ'd to retardate the working of Ale extremely; and it is observed, That Must may be preserved sweet a long time in a deep Well, or if let down into the Bottom of a River; and will when taken up, be less apt to ferment than other parcels of Must kept in the

warmer Air.

It hath been observed in the Northern Countrys, That the most Spirituous Parts of Liquors, have been separated and Collected together by a Congelation of the Phlegm; wherefore to try what Cold would Effect in our Climates, I hung out a Bottle of Beer in a sharp Night; and found, That most Part of it being froze, the Liquor which was not froze, was very strong and Spirituous; the frozen Part being Spiritless. But Rectifyed Spirit of Wine tinged with Cochineel being mixed with Water, Congelation separated not their Parts, nor did it separate the red and the Watery Parts of Claret, I made feveral Tryals upon Milk and Blood, as also on Vinegar, in which my Attempts proved infatisfactory : But a Solution of Salt being made in 24 Parts of Water, fo that it was as strong as the Sea-Water about us, I caused it to be exposed to freeze in a flatVessel, which was the larger, That the Superficies of the Water might

might be confiderable; and when it was covered with a Cake of Ice, that being taken off, it acquired another; which, when disfolved, yielded Water, not near fo Salt as that which remained unfroze; and being Hydrostatically

weighed was confiderably lighter.

Having exposed feveral Vegetable and Animal Subtances to be froze, I found, That by that means I could discover, their fucculent juices, and fqueez them out in the form of Ice, which being done; by cutting them transversely and length ways, I could discover also the Figure and Size of the Pores in which those Juices lodged. Amongst the Animal substances exposed to freeze, were the Eyes, and the Brains of Animals; which by being froze would be fitter to be dissected; the latter, when cut in two feeming like an Apple froze, the Ventricles and it's whole substance being filled with ley Particles.

Nather an Eye nor a Liver, lean fieth or fish, nor a living Frog; would be crusted over with Ice, as Eags and Apples are, when put into Vater; after they had been froze. As for the Reason why fiesh is usually much impaired by being froze, I suppose it to proceed hence, viz. That the Alimental Juice being expanded by freezing hath not it's own texture altered only, but even the solid Vessels which contain it, are thereby bruifed and crushed; for from several Experiments it is evident, That Eggs will be burst by the freezing of the Alimental Juice, and that the Textures of Stones and Vegetables will be destroyed by the Powerful Congelation of their respective suices, which will be less

wondered at, if we consider that Aqueous Parts by their Expansion were able to burst the Barrel of a Gun: Had I had leasure and conveniency I would have tryed what Effects Cold hath upon Animals froze to Death; but having exposed a Rabbet to the Cold all Night, I found that only one Leg was swelled and a little stiff. But a strangled Rabbet being exposed to be froze, Ice was produced in several Parts.

It is affirmed by several Modern Writers, That if Water be impregnated with the Salts of Vegetables; upon Congelation, they will represent the shape of the Plant they belong to: But notwithstanding I have several times tryed the Experiment, I found it either false or very contingent; fince it did not once answer Expectation. But having exposed a Lixivium of Pot-ashes to freeze; I found, That the Chrystals upon the Surface of the Water were Prismatical, and that under those lay a great many thin Parallel Plates of Ice; but not ranged in such an order as to represent the shape of Trees: And tho' Bartbolinus tells us, That if a Decoction of Cabbage be froze it will represent a Cabbage; yet I could never find, That the Experiment succeded, except that once there appeared the faint resemblance of a fingle Leaf. But I have found, That fair Water froze would represent the shapes of Vegetables oftner than their Decoctions. And tho' Berigardus also affirms the same; yet I suspect, That he only wirt, without trying the Experiments himself.

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Book IV

And yet, I deny not, but that prepoffeffed Spectators may fancy they fee fuch things when they do not, for tho' Sea-Salt and Allum confift of Parts of determinate Figures; yet when dissolved in Water they exhibit Figures too various and extravagant, not to be referred to Chance. And on this occasion, to what hath been faid I shall add, That by Distilling and rectifying Oyl of Turpentine from Sea-Salt in a Glass-head, as the degrees of Heat were varyed, so would the Figures of Trees be represented different on the infide the Glass. And I have feveral times produced the shapes of Trees from Bodies belonging to the Animal Kingdom: And I have found, That tho' Figures curious enough would be represented by Spirits, Solutions, Decoctions, Vinegar, Milk and even common Water; yet it was in vain to hope for the same success, and that the like Figures should always be afforded by the fame Liquor; fince very fmall Circumstances would vary them considerably: And in trying of fuch Experiments as these it may not be amis to advertise, That it will be convenient, that the Liquor should be as shallow as it possibly may, That it may be more speedily froze.

A frozen Egg being Put into Oyl of Turpentine instead of common Water it gathered

not about it any crusty Film.

It is observed by Mr. Wood, That tho' New-England be 10 or 11 degrees remoter from the Pole; yet the Wintersare much more piercing and Cold than ours. And to what hath been been delivered in the XVIII Title of the infrigidating Power of Wind, I shall add, That fometimes it hath been so much more Cold than at others, That being blown through the frigorifick Mixture, it would cause not only the Spirit of Wine to subside; but being blown upon the Ball of another Weather-Glass; not only the Liquor; but even Mercury it felf would be forced to ascend, the Vicinity of the frigorifick Mixture could not cause that Effect. And I have often tryed, That when the Temperature of the Air was such, that tho' when first blown upon the Ball of a nice Thermoscope; it would not cause the Liquor to ascend; yet at another season the Tinged Liquor ascended, as if the Air by being more than ordinarily compressed in the Room, had some sensible Effect in compressing and contracting the Air included in the Thermoscope.

To try whether Liquors, by losing their fluidity and becoming consistent would acquire a greater degree of Coldness, I caused the Ball of a Weather-Glass to be immersed in Sallet-Oyl, and a Solution of Minium in Vinegar, or of Quick-lime in Water, either of which will coagulate the Oyl; but I did not find, That the Mixture tho' consistent was Colder than

the fluid Ingredients.

To try whether Water was capable of Compression, we took a Glass-Ball with a long Stem, and filled it with Water within two Inches of the Top; then we Hermetically sealed it up, and freezing it from the Bottom upwards in a frigorisick gorifick Mixture, when the included Air was compressed as much as we thought the Glass would bear, we nipt off the Apex; and found, That thereupon the Air slew out and the Water rose & of an Inch above it's former Surface: So that it seemed to be compressed & of the length of the Aqueous Cylinder; but whether this Phænomenon might be occasion'd, by the Spring of some latent Air in the Pores of the Water, or whether it might be occasioned by some Springiness in the Ice, or whether the Glass being before distended and now reduced to it's former Dimensions occasioned this Phænomenon, I will not undertake to determine without further Tryals. And,

To what hath been observed in this Experiment, I shall add, That if the Apex were broke off before the Air was much compressed, it would cause no considerable Noise: And further, when the Experiment was a second time repeated with one of the same Glasses, and the same Liquor; it would rise # and # in the Stem, higher than before, upon breaking of the

Apex.

CHAP.



CHAP. VI.

An Examen of Antiperistalis, as it is usually taught and proved.

THO' the Doctrine of Antiperistasis be Arguments asserted by Aristotle; and some of his fol-alleaged in lowers urge Reason and Experience in favour anAntiperiof it, yet from what follows it will appear, stafis. That what is offered is not sufficient to main-

tain his Doctrine.

For first it is Reasoned in favour of it, That nothing can be more requisite for the Preservation of things, and more agreeable to the wisdom and goodness of Nature, than to furnish Cold and Heat with a self invigorating Power, which each of them may exert when encompass'd with the other; and that nothing is more Natural, than for one Quality, when furrounded with a Predominant one, to retire into the innermost recesses of that Body; where the force of it being increafed, an occasional Exertion of that Power is called Antiperistasis.

But from Reason to proceed to Experience, it is offered by the maintainers of an Antiperistalis, That in the Summer, when the lowest and uppermost Regions of the Air are insupportably Hot, the Cold flyes to the middle Region of it, and there defends it felf against the other two about it: And as the Cold remains in the middle Region, by virtue of an Antiperistasis, so Lightning is but an Explosion

of Exhalations pinned up in the Cold.

And

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And

And to this it is further offered, That the Effects of Antiperistasis are not only evident in the Air, but the Earth it self; for in the Summer, when the Air above the Earth is Hot, that in Cellars to which the Cold retreats is of a contrary Quality; and on the contrary in the Winter, when the Air without is excessive Cold, that in Vaults and Cellars is warm; and even the Water drawn from Wells is warm, when at the same time Rivers themselves are

covered over with Ice. And,

To these things it is further offered in Favour of an Antiperistasis, That in deep Pits as well as Mines, it is observed, that the Air is troublesome hot in the Winter: And that it is further observed, That the Water in Charlton-Island hath been observed to be much Colder in June when lee swam in it, than in December; and that a Well which furnished them with Water in December, afforded none in July; and further, That in Musco the Cellars are able to defend them in Winter from the Excessive Cold; and that even in those Gelid Climates, Water drawn out of Wells usually steams or smoaks if agitated when newly drawn.

Those Arguments exmined. Thus much being offered in favour of the Doctrine of Antiperiftajis, it is answered on the contrary; first, as to the rational defences of it, That there it no necessity that these two Qualities should thus invigorate themselves, there being no danger of them being lost out of the World; since without the help of an Antiperistasis, there are several substances, which are plentifully stocked with matter to supply each Quality: Besides, according to the

the course of Nature, contrary Qualities rather destroy than preferve one another; and even the Peripateticks themselves allow, That all Agents act as much as they can. And we have feveral Instances in the Northern Countries. That the Natural Heat of Animals is deftroyed and not increased by the help of Cold; and tho' it be commonly alledged, to shew that Contraries endeavour to shun each other. That a drop of Water falling upon a Table keeps in a Globular form; yet the Reason of that feems only to be this, viz. That the specifick Gravity of the drop is not so far prevalent above it's Tenacity, as to cause it to fpread; besides, it is prevented partly by the Ambient Pressure of the Atmosphere: And that it's Globous Figure is not owing to its aversion to spread upon a dry Body, and its disposition to shun Contraries is evident, since it retains the like Figure when mixed with fluid Oyl; and Mercury' on the contrary, tho' it be apter to retain a Globular Figure upon a Table, yet if put upon Gold it loses that Figure.

But to pass by what Reasons may be offered whether against the Doctrine of Antiperistasis: To pro- the Phane-ceed to examine what Experiments and Obser- flacked vations have been alledged in favour of it; I Quick-lime thall first observe, That the flacking of be an Arguick-lime with Cold Water be generally Antiperilooked upon to be an Effect of Antiperistasis; yet it appears otherwise, fince it will cause a much more violent Ebullition, if boiling Water be made vie of instead of Cold; the Parts of the hot Liquor being much more apt to pene-

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trate

Parts at Liberty; for which Reason, Spirit of Salt causes still a stronger ferment than hot Water. But to shew further, That Water slacks not Lime, because its Coldness keeps in, and thereby invigorates the Power of the Igneous siery Parts of the Lime, I put a piece into Oyl of Turpentine, which did not in the least dissolve it, nor did Spirit of Wine, tho upon the removal of it into Water, it was presently dissolved.

Another Argument Examin'd Another Argument alledged for an Antiperistasis, is the freezing of a Pot to the Top of a stool at the fire fide, by a mixture of Snow and Salt; but this Experiment having likewise succeeded, where there was no fire near, it could not be said that the Effect depended upon the force of the fire invigorating the Cold.

Another Experiment employed by the Afferters of an Antiperistalis is, That if a Pot of Snow be set over the sire, and a Vial full of Water be placed in the middle of it, it will upon the melting of the Snow be turned into Ice; but this Experiment having been often tryed, succeded not; yet tho' it should, any other Agent which would melt the Ice would as soon produce the Effect.

What the feverel Regions of the Air offer in Favour of Antiperistalis.

But as a further Argument of an Antipaisfass, it is urged, that in the Summer the lower and third Regions of the Air are Hot, and the middlemost Cold, which to me seems rather asserted; than proved, for not to insist on this viz. That according to the Peripateticks, the Natural State of the Air being Hot, I see not how it should be Cold in Summer, nor

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can I fee why the Third Region should be fo Hot, fince it lyes so far from the Superficies of the Earth, that the reflected Rays of the Sun cannot reach it; and that it be urged that it is Hot, because Meteors have been kindled there; vet the same Argument would prove the middle Region Hot, fince Meteors and Lightning have been observed there; and even in the lower Region; it being common in Storms fort hole fires called Helena, or Castor and Pollux,

to hover about the Masts of Ships.

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It is an Aphorism of the Great Expocrates, An Aphorism of Hyventres byme effe Calidiores; but this being pocrates exgrounded upon a Supposition that Digestion amin'd. depends on Heat, and therefore it must be greater in Winter, because Men have sharper Appetites; All that I need to offer to repugn this, is,. that Digestion is not performed by Heat; fince feveral voracious Fishes digest very ftrongly, whose Stomachs and Blood is Cold. But the' Concoction depended chiefly upon Heat; yet the greater Heat of the Stomach in Winter could not be attributed to Antiperistasis; but a Recention of Hot Humors generated in the Heart, which gradually increating, produce in all Parts of the Body a more than ordinary Heat, and by that means prepare a greater Quantity of the Stomachical Menstruum, Belides Contraries themselves, in respect of other Qualities, agree in this, That they increase Appetite, as Spices, Wine, and Vinegar; and also Wormwood and Juice of Limons. And Fromundus hath observed, That he himself hath been taken with a Braspia upon walking upon Snow, which fince they are

not fo frequent in the Northern and Colder Climates, I am apt to believe proceed from fome other Particles conveighed into the Blood

Hail is thought by the Aristotelians to be

along with those frigorifick Atoms.

The Arifto- generated in the lower Region of the Air. telian Pro- the drops of Rain that fall out of the middle dustion of Region being there congealed, by an Antiperistasis, and that it is only generated in Summer. But on the contrary, I have observed my felf the greatest shower of Hail that ever I faw to fall in January, when the violence of the Frost had rendred the lower Region of the Air Cold; at which time a Servant to one of my Domesticks told her Master, That she was led out of her way by an Ignis Fatuus, which, etill she could follow it no further, she took to be a Candle, carryed by another Person before her; where how the Nocturnal Air could kindle a fiery Meteor by it's Coldness, and congeal Snow by it's Heat, I profess I cannot understand : Besides were Aristotle's account true, I fee not why they should never fee it Hail at Alexandria and Pelufium, places in Egypt, where the lower Region of the Air is hot enough, and where it rains frequently; befides we have feen Grains of Hail larger by much than drops of Rain, and at Lyons in France the Virtuoli took Notice of a shower of Hail whose Grains were as large as a Tennis-Ball; and Bartholinus tells us. That he himself hath observed some so large, That they weighed a Pound; and to thefe I shall add, that the Aristotle afferts Hail to be generated in the lower Region, and Snow in the upper, I have obferved

ferved Grains of Ice, which contain'd Snow in the middle of them.

The next Argument alledged in favour of Antiperistasis, and to be examined, is the Coldness of Cellars in Summer, and their Heat in Winter.

And first, I deny that the Air in Cellars is cooler in Summer than Winter; fince the reafon why we feel it fo, is only the Predisposition of our Senfories, which are comparatively warmer, by being enclosed in fo warm an Air as that they are encompassed with in the Summer: But supposing, that not only our senses, but Weather-Glasses should inform us. That the Air in Cellars were Colder in the Summer than Winter; yet it might be accounted for without an Antiperistasis: for since there are several hot Effluvia sent up from subterraneal Parts, these restrain'd and kept from flying away in the Winter, may alter the temper of the Soil, and Subterraneal Waters; but when by the Heat of Summer the Pores of the Earth are opened, and way is made for the Avolition of them; upon that account the Superficial Parts of the Earth may be a little cooler.

And for a like reason; we may think Cellars hotter in the Winter than the Summer, if we judge of them by the Testimony of our Senses; lince we are not there affected with those Winds and External Agents of Cold; as in the open Air; and therefore to one that comes out of the open Air into them, they may seem Warmer.

But that Cellars are Colder in the Winter than the Summer, when we estimate the degrees

of them by Bodies that are not alike fubject toPredispositions as our Bodies are; will appear from what follows. And first two sealed Weather-Glasfes being hung out in a frosty Evening, till they were both of an Equal temper; the one of them remov'd into a Cellar, in two or three Hours ascended five or fix Divisions; whilst that which remain'd in the Air rather descended than role; but in the Morning that in the Cellar descended a little, so that the outward Air instead of Increasing rather Diminished the Heat of the Cellar: And Oyl which in thawing Weather was usually Liquid, being placed in a Cellar in a frosty Night, was congealed; fo that it would subside in other Oyl: And I have further observ'd. That Oyl that was froze in the Cellar upon a thaw rose instead of sub-. fiding according to the Doctrine of Antiperistafes. And in Poland it is observ'd. That in the Winter small Beer freezes in the Cellars; and the like I have observ'd in England in a Cellar, which in the Summer kept Beer cool enough. And I am told, That in Russia, the Cellars are fo far from being fo Cold in Summer as in Winter, that they are forced to keep their Beer in the Summer in Water froze with Snow, and to dig their Barrels out as they have occasion.

But tho' we should allow, That some Cellars and Vaults are warmer in Winter than Summer, yet it does not therefore follow, that it must be the Effects of an Antiperistasis; since it may be done by the Influence of Subterraneal fires; for which Reason deep Cellars are generally warmest: And it hath been observed.

That

That the deepest Mines in Hungary are always the bottest; and tho' the upper Region in some measure seems Cold, yet that may easily be caused by the Predisposition of our Sensories, when out of the warm Air we find it comparatively Colder in the top of the Groove, and in our ascent Colder in respect of those Regions which are nearer the Instuence of Subterrançal sires. And that the lower Regions are hotter than the uppermost, is not only evident from what hath been elsewhere delivered; but from what Arch-Bishop Upsal hath observ'd in the deep Mountains in Poland, from whence

they dig Rock-Salt.

And tho' the Heat of Springs in the Winter may be alledged by fome as a cause of Antiperistasis; yet it is easily otherwise explain'd. fince the Subterraneal Effluvia of the Earth, as well as the Comparative Coldness of the Air is fusficient to folve that Phanomenon: And that the Antiperistasis is not so powerful in the Winter, as to have any effect on the Subterraneal Parts is evident; fince Capt. James tells us, That he had a Well which remain'd unfroze all Winter; so that by breaking the Ice on the top they could get fresh Water: And it is attested by a Latin Author, That in or near the Island Hueena, wherein the famous Tycho built his Urani-Burgum, there is one Spring which is not froze in Winter, and Olaus Magnus tells us, That near Nidrofia, one of the chief Cities of Norway, there is a Lake that in that Northern Region never freezes. And Josephus informs us of a hot Spring in Peru, from whence the Waters iffue out boiling hot; yet a Spring

which is just by it is Cold as Ice; so that the Nature of the Soil through which Bodies flow, may have a considerable stroak in altering the Temper of the Water. And to savour what I have said of the Reason why Springs steam in the Summer, I shall add, That it is observed, that our Breath as well as the steams of Issue are visible in the Winter; tho' not discernable in the Summer; and the very steams of a labouring Man have been froze on the outside of his wastcoat whilst he was working. And it's commonly observed, That the steams of a River are very apparent in the Evenings, tho' not discernable at Mid-day in Summer.

And that the Earth is not only heated by those Subterraneal steams, but that those Meteors which we frequently see, proceed from Subterraneal Essuvia, will be rendred probable, by observing, That Miners usually foretel Storms and alterations in the Air, by the damps which rise in their Mines: And in Comwall it is observed by the Fisher-men, that those Sulphureous Exhalations which appear like fire up and down, generally precede considerable Storms. And the like hath been observed on the Coast of Ireland, when a black Cloud like a Barrel rising out of the Water, a violent Storm presently succeeded.

And an Anonymous Writer tells us, That in Comitatus Zotiensis in Hungary, a Clift of Ground emits such steams, that Birds and Cats or Dogs being held over it are killed by the steams of it: And the same Author tells us, That near the City Buda, there are such hot Springs, that the River Danubius is not able

to

to keep them cool; and he tells us likewise, that in the River Istroganum, they may discover hot Springs; by removing the sand with their feet. And I am inform'd by credible witnesses, That in the North of England there is a ditch which emits steams, which are instamable; and probably there may be other places which emit such kind of Essays, and afford matter

for fiery Meteors and Winds.

And we are told. That not only in Muscory. a Tract of Water a Mile long continued unfroze, when the rest was, and emitted hot fleams: But Olaus Magnus tells us of a Lake Veter, which thaws with a confiderable noise, That as well as the River Peking near China, which thaws in one Day, beginning at the bottom and so thaws upwards; and in these thaws it is observ'd. That they are foretold by a great boiling of the Water first under the Ice. And that such Effluvia being detained from flying away, and kept up in the Earth may contribute to the Heating of Cellars appears further; fince in Muscow, when a Cellar hath been long kept shut; when first the door is opened, the steams will affect the Men so Powerfully, as almost to suffocate them.

So that from hence it appears, That the Retention of hot Effluvia depend on a Conftipation of the Pores of the Earth; and not on the Disposition of hot Vapors to fly away from their contrary; since we see that they have no such Disposition, the Vapors of a Well rather dispersing themselves in the Air than slying a-

way from it.

But

But to disprove the Doctrine of Antiperistasia, further, I shall add, That a rod of Iron, which had a piece of Iron fixed to one end of it, having that end made red hot, and quenched in Cold Water, the Heat did not recede into the other end, to avoid the Coldness of the Water.

But a more convincing Experiment is, That a Weather-Glass being suspended in a wide-mouth'd Glass in Water, when that Glass was placed in hot Water, the Coldness of that in the wide-mouth'd Glass, was so far from being drove upon the Weather-Glass, that the Spirit of Wine did not in the least subside; but when the Heat of the External Water was diffused through the other, it manifestly rose. And this Experiment being try'd with warm Water in the wide-mouth'd Glass, and Cold Water about that, the Heat was not more intense about the Weather-Glass; but when the Cold had diffused it self through the warm Water, the Spirit of Wine subsided.

Post script.

Tho' from what hath been said, it appears, That the Doctrine of Antiperistasis is not without Reason exploded; yet I shall suspend my Judgment, whether Cellars are warmer in the Winter than the Summer or not; since the learned Jesuite Zucchius tells us, That having suspended a Weather-Glass 3 years in a Cellar, the Water would-rise in the Winter and descend in the Summer. And another tells us, That he knew a Well Colder in Summer than

Winter,

Winter, yet I am far from believing this Obfervation universal; since what hath been said evinces the contrary; for, tho' the superficial Parts of the Earth are subject to vary in their Temperature, as the Weather influences them; yet Subterraneal Cavities that are very deep are neither hotter or colder in the Winter or Summer; and tho' Zucchius hath undertaken to measure it by the assistance of Weather-Glasses; yet fince ordinary Weather-Glasses are subject to be influenced by the Gravity of the Air, as well as the Heat and Cold of it; and fince some places are fuller of Subterraneal Vapors than others, and confemently the fudden ascent of Exhalations may presently increase the weight of it, I think the following Experiment made by the learned Maignan sufficient to ballance what Zucchius hath delivered, and therefore I shall deliver it in the Authors words. Expertus ego sum (says he) Thermometro fidelissimo & a præcedente byeme in sequentem æstatem prorsus invariato, instructo etiam tali aqua, nempe in boc ipsum, ex præscripto Trebellii ita comparata ut non exbaletur, neg; minuatur, expertus inquam sum, in supradictis optimis cellis Vinariis maximum, quod ardentissima astate fuit, frigus non adaquasse illud quod ibidem crat brumali tempore, ut dixi -- si quidem in Tubo vitrei Thermometri quatuor circiter palmos longos & in octo gradus Graduuma; minuta diviso, aqua byeme ascendit ad Gradus 7 cum semisse, æstate autem vix gradum fextum superavit, cam tamen ad sensum multo magis vigerat frigus istud astivum.

CHAP.

CHAP. VII.

An Examination of Mr. Hobbes Doctrine of Cold.

Mr. Hobbes A fr. Hobbes in his Doctrine of Cold tells ms. Dostrine of IVI That the Air being put into an Expanfive motion by the Beams of the Sun, it is beaten down upon the Surface of the Earth; where finding a reliftance below, it spreads it self every way towards the Poles, and as the Parallel Circles grow closer towards the Poles, fo the Air being straitned and more condensed

causes a greater degree of Cold.

To which he adds, That as the Air moves betwixt these Parallels, it rakes upon the Surface of Water, more or less as the Air is more or less straitned; by which means the Water not only tending towards its Centre by its own Gravity, but being also condensed by the rakeing Pressure of the Air, the Surface of it is first congealed, and then it gradually defeends; and for alike Reason when Water is immersed in Snow and Salt, the Mixture melting those very Parts which lodged in the Pores of it, they rakeing against the sides of the Glass, give it fuch a motion, as when communicated to the Water contain'd in it causes it to congeal. And for a Reason not unlike the former, the Particles of Air contain'd in Clouds being in their descent squeezed out, rake the drops of Water in their passage, and so harden them.





And the Reason why serene weather is Colder than rainy weather, he says is; because the force of the Wind is broken and dissipated by the falling drops; which Reason he likewise alledges, why Water in Wells is not froze, the Wind not being able to beat strongly enough upon the Surface of the Water.

And as for the Reason why Ice is lighter than Water, he attributes it to Airy Particles, forced

into it whilft it is congealing.

But it may easily be urged against this Do- Examined. ctrine, that all congealed Liquors, instead of having their Parts prefled inwards, and fo condensed, manifestly expand upon Congelation. And as for Animal Bodies, such an inward indeavour of the Humors, as his Doctrine suppofes, is not requisite to produce a sensation of Cold; fince a decrease of the motion of the fluids about our Sensories, or an Impulse made upon the fensitive Parts, by some alteration in the motion of the Blood and Spirits, or a turbulent motion of some excrementitious Particles hindred from flying away is fufficient; so some Hysterick Women perceive a Coldness on the top of their Heads and the Vertebra, when they are otherwise hot; and Avicen tells us, That the biting of some Vipers in hot Countries causes a sensation of Cold; And I know a Noble Man who feels an extraordinary Coldness upon him, when he is seiz'd with a fit of the Stone. And an inward compression of the Parts of a Body is so far from being sufficient to produce Cold, that compression in some Bodies produces Heat.

But

But to examine what he alligns as the Grand Cause of Cold, viz. Wind, which according to him is Air moved in a considerable quantity, and that either forwards only, or in an undulating But against this Doctrine I have feveral things to offer. And first, That several frosts are begun and continued when the Wind is ferene and calm; and that a gentle Northeast-wind is much Colder than a boisterous Southerly Wind. Secondly, That the Wind which iffues out of an Lolopile is not Cold but Hot, tho' it moves more violently than the Wind which is blown from the Mouth. Thirdly, We have made it appear, That Water will freeze, tho' fealed up in a Glass, and tho' that Glass be inclosed in another, so that the Wind cannot beat upon it; and even an Egg frozen will be crusted over with Ice, when fuspended in Water, so that the External Air cannot Effect it.

And tho' he tells us, That all Winds produce Cold: Prosper Alpinus in his Medicina Ægyptiorum acquaints us that he hath found the Winds in those Torrid Regions insufferably hot. And Marcus Paulus Venetus tells us. That the Winds near Ormus have been fo hot as to destroy an Army of Men at once: And tho' fome Winds put into motion feel Cold, yet that depends on the Predisposition of our Sensories, and the deeper penetration of that fluid into the Pores of the Body, in respect of which it hath a comparative Coldness; and that it is but a comparative Coldness is evident, fince the same Wind blowing upon a Weather-Glass affects it not at all; except sometimes by accident, accident, when, by that means, fom calorifick Atoms swimming in the Air, are driven away by it. And tho' Mr. Hobbes tells us, that all Winds cool by diminishing former Heat, yet we see, that Water actually Cold, becomes still Colder by freezing, where the Heat cannot be said to be diminished in a Body actually Cold before.

But to proceed, tho' Mr. Hobbes says, that Wind is generated upon the Surface of the Earth by the action of the Sun; yet he tells us not how that Wind must produce Cold; nor does the motion of it towards the Poles help the matter, since we have shewn, that motion in it self is not sufficient to produce Cold; and should he say, that the Coldness is derived from the Mixture of freezing Vapours in it's passage, then those steams would rather be taken for the cause of Cold, than the Wind; and then I should ask him, Whence the Coldness of

those Cold Vapours proceeded?

Besides, since in his account of the freezing of Water, he fays the Parts of the freezing Water will be raised in Congelation, I see not how it will happen; fince Oyl and feveral other Liquors are contracted by it, and I have not yet feen any one Instance in which Water was ever congeal'd by a Compression: Since when we inclosed Water in a Pewter-Bottle and beat the sides of it together, till the Water made its way out; we perceiv'd not, that that powerful compression had in the least inclined the Water to Congelation. And the we should allow, that the Saperficial Parts of the Water might be froze as Mr. Hobbes teils us, yet I fee not how the Air can beat upon Water, fevered from it b/ Ice nine or ten Foot thick. B:fides M *

Belides, I think it altogether inconceivable, how Wind by raking upon the outside of a Glass, should cause the Water within to freeze, since the freezing of Water is an action much different from the putting of the Glass into a trembling motion; besides we see, that Water will not be froze by the blowing of a strong Wind against the outside of a Glass, tho it will when enclosed in Liquors where no Wind can come at it, and those two which are not subject to freeze themselves.

And whereas Mr. Hobbes gives it as a Reason why some Wells freeze not, because the Wind hath not liberty to blow strong enough upon the Water, I shall add, that those Wells that are subject to be froze when Northerly or Easterly Winds blow, will freeze, tho' covered over and sufficiently guarded from the Winds; and in Cold Winters, whether the Wind blows

or not. And,

Whereas Mr. Hobbes tells us, that the lightness of Ice above Water, proceeds from the bubbles received into it whilst it is freezing; the Contrary is evident, since Water froze ina seal'd Glass, will be plentifully stocked with bubbles as well as that which is frozen in the free Air.

Postscript.

To conclude this History of Cold, I shall instead of some other Experiments designed for this Treat se, subjoyn an Experiment elsewhere mention'd in the History of whiteness and blackness

ness, viz. Take a piece of Cork and having burnt it, till it be reduced to a black Coal, and then having flacked it in fair Water, it will, by being mixed with Gum-water, form a black Ink, which you may write what you please with; which writing if it be interlined with a colourless Solution of Minium in Spirit of Vinegar, upon wetting the Paper with a foungedipped in a fluid Liquor, prepared by mixing three Parts of Quick-lime and one of yellow orpiment, and digefting them two or three hours in fixteen Parts of Water, the invisible Solution of Minium will exhibit black Letters, and the other black ones will disappear; but whilst this fetid Liquor is preparing, it must be well shaken several times, that the Quick-lime and the powdered orpiment may the better impregnate it, and then the decanted and filtred Liquor must be kept for use.

But belides this, there are feveral other ways of making lnk, which I could be glad to learn : And I my felf have tryed that Words might be writ with a Solution of Minium, which I could render legible by the help of the

fire:

CH AF. Ms

CHAP. VIII.

An account of Freezing made in December and January, 1662. By Dr. Merret.

Several Experiments about freez. ing.

THE following Experiments were made in Weather which was very frosty, continuing six weeks, yet not without some alternate Relaxations, in Stone-Windows exposed to the North and North-East-Winds. The Vessels in which they were tryed were Glass-Canes of several Bores, Earthen and Pewter Vessels &c.

Cold Water exposed to the Air in open Pans was froze in an hour, boiling Water in two; boiling and Cold Water mix'd in 1; the Cold Water beginning to freeze at the top and and sides, but the other at the bottom; and when the Water was Cold at the top. fame succeeded, with Water thrown upon a Table, the Cold Water being first froze. A four ounce Vial with a Stem a Foot long and half filled, being exhausted of Air in Vacuo Boyliano, was almost froze as soon as Water exposed in an openPan, and appear'd white seeming to confift purely of bubbles. Water in which Arsnick was eight Months infused, congealed into white Ice fooner than Water, and fo did Solutions of all forts of Vitriols; and fooner than Solutions of other Salts; except Allum, which froze into an Ice whiter than Milk, and fluck fo fast to the Pan that I could scarce separate it.

Sandever

Sandever presently freezeth, but Eris sooner, and Kelp in less time than that; all of them forming white lumps of Ice. Sal-Armoniack frequently froze before the rest of them, but once after them, Two drams of common Salt dissolved in four ounces of Water was in hard frost congealed into a white Ice in about thirty hours. Stinking Sea-Water full of Salt being exposed in a Beer-Glass, was covered with a film of Ice as thick as 1 a Crown in twenty fix hours; when froze it tafted Salt and smelled stinking; but when thawed it had loft the fetor : In four days more the whole was froze, but that in the bottom tafted sharper than the rest. The same Water in broad Pans was quite froze through in thirty fix hours, and sooner in a Mixture of Snow and Salt; neither a strong Solution of Salt-Petre, no. Bay-Salt, nor Sal-Armoniack were froze in fix days. But a Solution of Salt of Tartar froze in a little more time than Water; and being exposed in a Tube it began to freeze at the bottom, top and fides all once; whereas other Liquors freeze uniformly either at the top or bottom first.

Salt-Petre in a Cold feason was in twenty eight hours froze into a white Ice, which was mistaken for Sal-Prunel, and sparkled in the fire as that Salt usually does. A lixivium of it made with Copperas or Allum lingly or mixed, set in Snow and Salt or Snow alone, was frozen in one Night. Sal-Gem, tho' Snow and Salt were mixed with it, and tho' it were set in Snow and Salt, would not be brought to freeze. But Phlegm of Vitriol froze sooner than the So-

lutions before mention'd

M 3

Oyl

Oyl of Vitriol is coagulated sooner than any of the afore mention'd Liquors, except Water; a large Tube being filled with it, and being froze, tasted of a strong Vitriolate taste; the coagulated Part, was of a paler colour than the other, and both being poured together in a Bottle, it became too hot to hold in one's hands, this coagulated Part remain'd unthaw'd a week after the rest of the Liquors; and another Tube of the same Oyl being wholly froze, it subsided an Inch below its station to which it rose again upon a thaw, but the

other Liquors role upon congelation. A flask of small Beer froze in thirty eight hours, but three Parts of Ale continued unfroze after fix days hard Frost; but at four a Clock in the morning, the unfroze Liquor tafted much stronger and brisker than before it was froze; the Ice was less firm and fuller of bubbles than common Ice, and being thawed was very pale and of a quick Aleish taste. A Beer-Glass of Hull-Ale being exposed to the Cold in a Glass, in twenty four hours was crusted over with Ice, as thick as half a Crown, and that being taken off, it yielded another; and fo fuccesfively, till the whole was froze; these Lamina were all of the fame colour and tafte, but the lowest was the most tender: This Ale would not freeze fo foon as that which I exposed be-

fore. Hull-Ale hath a brackish taste.

Claret exposed in a spoon, in thirty five hours was turned into a soft Ice, which had the Genuine colour and taste of Wine. In thirty eight hours Canary exposed in a spoon was covered with a thin film, which grew no thicker in





four days. But neither Claret or Canary would freeze in Tubes or Bottles.

Two ounces of Spirit of Wine exposed in a spoon all evaporated in twelve hours; but the same quantity of Brandy left about a spoonful of see void both of taste and it's Instammable Quality; but being held betwixt my Eye and a candle it discover'd several bubbles.

An Ox and a Sheep's Eye were both frozen through in one Night, the three Humours being Opacous, hard and inseparable. The Chrystalline humour was white like Whitings boil'd, the waterish and glassy humour seemed

to be made of flakes of Ice.

Sheeps Blood exposed to freeze, the Serum was turned to Ice, which, being separated from the Blood and thawed at the fire, congealed a second time into a Membranous substance; but the Blood was not in the least froze. The Heart and Blood in the Vena Cava of a Dog and Cat exposed dead to the Air were both froze: Milk froze into white flakes, being foft and with few bubbles in it, and retaining the proper tafte of Milk. The yolks and Whites of Eggs were froze in one Night, they thaw best by lying on New-Castle Coals or in a deep Cellar: I am told that Eggs, tho' they have been froze, will produce Chickens-Eggs held near the Surface of the Water when froze will acquire a crust of Ice on the outside, the inward Parts of it still remaining froze; and if those Eggs whilst froze, be poched, they will be very tough. An Egg and an Apple being sufpended two Foot deep in a Ciftern and taken up after twenty four hours, tho' both of them

M 4 V

were full of Ice within, yet neither of them had contracted Ice on the outlide.

Horse-Radishes and Onions froze, yet Beer in which Horse-Radish and Scurvey-Grass are infused will not freeze so soon as strong Beer without them. Oranges and Limons froze, have a hard and tough rind, and lose their genuine tafte; and when thawed they foon become rotten: Apples Cut in the middle, will have a thin Ice on both plains, which may be difcerned by a knife or the touch. The skins of these Apples soon turn brown, and they begin to corrupt there. Oyl exposed look'd like Butter melted and coagulated again; but in Gaves and Cellars, it would never appear more than Candied. White Wine-Vinegar froze in a Tube without apparent bubbles. Whatever hath a watry humour in it will coagnlate. But what will not, the next Paragraph contains.

Spirit of Wine, Aq. Maria, Calestis &c, and Canary in large Vessels, Soap-Boilers Lees, Spirit of Salt, Vitriol, Salt-Petre, Aqua fortis, Spirit of Sulphur, and Spirit of Soot will not freeze, but the two last afford a Precipitate; the first of the colour and taste of Brimstone, but not inslammable; the latter a yellowish powder more bitter than the Spirit and inslammable. But they these Spirits would not freeze, yet being mixed with twelve Parts of Water, all of them froze except Spirit of Salt, Nitre and Aqua fortis: I am told that one having dissolved ice in the North Seas found it Salt.

As for the figures of Liquors froze, Allum/appear'd in lumps, Salt-Petre, Tartar, Milk, Ale, Wine and Sal-Armoniack in plates. And other



other Liquors which composed a soft ice, seened to be composed of Globuli adhering to each others. Water, Kelp and Frits resembled the sibres of an Oaken leaf, the interstices being filled up with smoother ice, and the middle Fibres, as in Plants, appeared larger than the others, and made acute Angles at the lesser end of the leaf. But as for the sigures of frozen Urine, those having been accurately described by the curious Mr. Hook, I shall pass that part of my task by.

I took the Salts of Rosemary, Rue, Scurvey-Grass, Mint and Plantan, and putting I or I of an ounce of each into I of a pint of their difilled Waters; the Rue and Plantan being sealed up, none of them froze resembled the Plants they belong'd to; but the Aromatick Waters were much enriched in their scents, efpecially the Rosemary; Relp froze represents

the leaves of Alga Marina.

A Recipient full of Water being froze and the top of the Ice broke, there appeared a Cavity within, which was thick fet with Plates of Ice from which Stiria appeared on each fide like the Teeth of Combs, some of which stood at such a distance that I could put my finger

betwixt them.

A flask full of Water being froze it appear'd full of bubbles like tailed hail-shot, the sharp points of all of them pointing upwards. They had Cavities which would admit a Pin into them and might be discerned in the Ice, appearing like black spots: And in the middle of the Ice was contained a Cavity filled with Water in which

which were several of these bubbles imperfed-

ly formed.

All the Liquors I made Experiments with, did sensibly rise above the mark, before they froze, and more after congelation. Vinegar and Urine rose i an Inch, and Lees made of Salts of Rosemary, Kelp and Frits, about I of an Inch. Solutions of Allum and Copperas less, and Saline Liquors in general less than Water, which rose a full Inch, and small Beer in a narrow Tube four Inches. Oyl of Vitriol alone subsides below the mark, hot Water subsides till it is cool and

then rifes again,

Water being froze in Beer-Glasses, rises up and forms folid Triangles, but the rifing of it is more visible in narrow Glasses: Ice in a flask rose four Inches above the Water-mark, and hong two Inches out of it, but in a Bolt-head it rofe five Inches above the Water-mark. If Glasses be filled about & full they feldom break. Round Spherical Glasses usually break uniformly. A Bolt-head being filled up to the neck with Water, the top which was twelve Inches above it, was sealed up; upon which the Water being froze, was raised three Inches into the neck; and the Glass breaking in the thinnest Part, from that point, feveral Lines ran as from a Pole to the Meridian, but none of them went round the Glass, nor were they all of the same length: In a flask cracked in many places the cracks were irregular : Glass Bottles and stone-jugs, kept little order in breaking, and Metals none at all, but Woods cleave with the Grain.

Two



Two oval Boxes, one of Box and another of Maple, containing each two ounces, were fill'd full, and by the Frost in one Night were cracked from the bottom to the top. A Pepper-Box of Latin, had its neck broke off and the joints at the bottom loofned. Lead-Pipes above ground were broke in many places, and some that lay a foot under ground: Brass-Locks and Barrels of Pomps usually break with the Frost. A Copper-Box of the fhape of a Pear was cracked the fourth time it was froze. The Cylinder of a filver Ink-horn bore the Froft, but a filverball was confiderably extended by the Frost. Tobacco-Pipes' and Earthen Ware were burft with the Frost, and Tiles of Houses and stone-Buildings scale upon a thaw; for which Reason the North fide of Buildings first decay. bafter and Marble that have chinks in them ufually break with the Frost, but folid Marble does not, nor does Frost affect those stones or Bitumens which will bear a Polish.

Ice laid on a Table, and having Salt strowed upon it, it stuck so fast that it could not be separated without being broke in pieces; and the Salt made its way through the see down to the board; but if Salt be strowed betwixt the lee and the board, it will not be froze to it but thawed. The following Salts canse not so firm an adhesion as common Salt, viz. Kelp, Sandever, Sal Indus, Gem, Prunel, Armon. and Potashes. A nail held betwixt my lips could not

be remov'd without difficulty and Pain.

A Tincture of Cochineel with Spirit of Wine, and another with a little Sea-Salt Water, being froze throughout, retained an equal colour in all

Parts

Parts, and fo did a Tincture of Mades weed, and Indico. A Decoction of Soot was froze without any Concentration; yet Mr. Hook, a worthy Fellow of the Royal Society, hath ob-

ferved the contrary effect.

Eggs and Apples froze differed not in weight, nor do Bodies weighed in fealed Glasses. Frost renders Wood, Iron, Steel and the Bones of Animals, more friable in frosty Weather; especially in those that are tainted with the Lues Venerea. Frost preserves Bodies from Putresaction, and confirms the Tone of Animals, and sattens some; it clears the Air, so that musty Stone-Bottles being fill'd with Water and froze, after a Thaw were very sweet; it likewise destroys Animals and Vegetables, so that in Greenland nothing but Grass grows, as also in Nova Zembla.

The quali-

As for the qualities of Ice, it is flippery, fmooth, hard, firm and strong, diaphanous, interposed betwixt the Eye and a Candle, appears in many round Circles, from whence proceed Rays, in the form of a Star, a quarter of an Inch in diameter. I have feen the Ice in the Thames eight Inches thick, and in Gardenwalks the Earth froze near two Foot thick, but in rich Soils it did not penetrate above a Foot and a quarter. Ice generally fwims, but I have feen Snow-bills, compressed and moistned with Water, fink Congealed Oyl of Vitriol finks. Ice is colder than Water, and that quality is increased by adding Salt or Snow. It hath no fmell, but checks that quality in other Bodies. It yields both Reflection and Refraction.

North



North and North-east Winds, the absence of the Sun, the highest Parts of Mountains, a mixture of Snow and Salt, promote freezing. Water falling upon Ice or Snow freezes, and a mixture of beaten Ice with Sea-Salt, Kelp, Allum, Vitriol, or Nitre, and Oyl of Vitriol, will promote freezing; and if Water be set upon such Mixtures, it begins to freeze at the Bottom; Salt Petre dissolv'd in Water, and agitated in a cold Season, turned not the Water into Ice. A Bolt-head being placed in Snow in a Pan, tho' the Pan was set on the Fire, and thawed gradually, yet the Water in the Bolt-head froze not.

Water frozen in Pans, being fet on New-castle Coals in a Cellar, and likewise on Sand, and on the Earthen Floor, they thawed in the same order; and so did Eggs and Apples. A Syphon may be made of Ice, through which Water will run very fast. Another use which may be made of Ice is for Refraction, of which Mr. Hook hath given a learned Demonstration.

Having formed Ice into various Figures, the fair which were the same as those mentioned by Diopurick Writers. We may likewise make a Speculum of it, by holding a piece of Paper behind it:

The Learned Bartholinus delivers the following Propositions of it.

1. That the more subtil distilled Spirits gain a clear splendour and elegancy from Snow placed about them.

2. The Rayes of Snow newly fallen, glitter and dazzle the Eyes: by reason of the multitude of Globuli, by which they are reflected.

3. A

3. A Cabbage putrified in that part which was above the Snow. And I have observed great Houseck, or American Aloes destroy'd by Cold in an upper Room; and Sea-Onions as well as common Onions will be putrified by the Cold.

4. Snow yields Vapours plentifully, when

melted by the Sun-beams.

5. It melts and falls off from Ivy.

6. It contains a little Earth in it; which I have found true by Evaporation.

7. Viscosity with Softness is greater in new

than old Snow.

8. Water-Cresses and Scurvy-grass will grow under Snow in Gardens; but I am apt to believe they are at a perfect stand, the nutritious Juice

being congealed.

9. Air is included in Snow. Whites of Eggs being beaten into a frothy Confistence, and this being laid on a Trencher, soon appeared to be Snow. A Pail being filled with warm Water, and Hair, Moss and a piece of Rosemary bung over it, the rising Vapors sticking to them formed a Hoar-frost, and the like is observed on the Beards of Men, and the Hairs of other Animals.

10. Snow abounds with Fat.

11. Snow with Ice fwims on Water.

12. Snow-water boils Meat fooner, and makes Flesh whiter. I could not find that this bolds in Fish or Flesh.

13. Snow newly fallen hath no tafte, but when it hath lain on the Ground, it bites the

Tongue. This I could not discern.

I 4. Worms are sometimes found in Snow.

19. A

15. A strong Salt may be drawn from Snow by a peculiar Art.

16. After much Snow plenty of Nuts. It

sometimes fails.

The Duke of Tuscany distill'd a Spirit from Wine, only by putting Snow upon the Alembick; and the Duke of Mantua had a Powder, which would freeze Water in the middle of Summer.

Weather-Glasses being framed after the Italian mode, and in part filled with tinged Spirit of Wine; I placed one of them in a North-west Window, and the other in Mr. Pullyn's Warehouse under St. Paul's Church, in the warmest place; the Spirit of both, when they were fettled on the fifteenth of Odob. 62. having the Altitude of three Inches; and when that in my Study-Window was depressed an Inch. in the Cellar receiv'd no manifest alteration: But when the other was depressed two Inches, it subsided a of an Inch, which was the lowest Station it subsided to all Winter; and in April following it rose not above the three Inches it first stood at, above I of an Inch, tho' that in my Study was railed four Inches 4. In this Cellar, Liquors that were froze above Ground. would be thawed in the Morning, The Spirit in the Glass above ground subsided into the Ball after two days hard Frost. Whence it appears, that Cellars are not hotter in Winter than Summer. One thing observable was, that the tinged Spirit had loft its Colour in the Cellar.

Book IV

In January, a Pint-Bottle of Claret, a Glass-Cane filled with Canary, a Solution of Sal Gem. Train-Oyl, and the Oyl of fructus Muse, in a Night's time were all troze, except the Sal Gem, in the bottom of which chrystallized Salts appeared. The Oyl of the Fruit became very friable, and of a milky-white Colour, but the Train Oyl only lost its fluidity, and became of the consistence of soft Grease. And the same Night, a Bottle of Rhenish Wine, and another of strong White-wine, were for the most part froze, the Ice tasting weaker than the Wine; but the Wine being several times froze and thawed again, neither lost any thing of its Colour, Taste, or Strength.

Mr. Hook shewed me an oval Glass, which had at one end a narrow Cane an Inch long, in which Water tinged with Cochineel being froze, the Ice on the out-side was colourless, but in the middle of a deep Tincture; and I have observed the like in Flasks containing the

same Tincture froze.

Flesh, Fish, Eggs, and Apples, being held near the surface of Water, and immersed in it, are crusted over with Ice; and I have observ'd that Mortar and Plaister of Paris will freeze.

I have feen Ice three Yards thick on the Banks of Thames, the Water which flowed fuccessively over the Ice being froze, and gradually thickening it; and I have froze a whole flask full of Water, by gradually pouring it into a Pan; which confirms what Olearius says of making huge heaps of Ice to preserve Bodies.

Tho' my Lord Verulam tells us, that Eggs and Apples cover'd with a wet Cloth will not freeze.

freeze; yet I have not observ'd any difference betwixt them and others.

Oyls of Animals, and vegetable Oyls by Expression, subside. Syrups freeze not. Cold affects not Loadstones sensibly in their Opera-Having exposed distill'd Waters of Plantan, Poppies, black Cherries, Night-shade, Scurvy-grafs, and Horse-radish to the Cold, in order to make a Standard for Weather-Glaffes, I observ'd that the Black-cherry-water was froze first, and the Horse-radish and Scurvygrass Waters last. The best way to discover when Liquors begin to freeze first is, by drawing a Pin through the surface of those Liquors.

CHAP. IX.

A new Frigorifick Experiment, Shewing bow a confiderable degree of Cold may be suddealy produced without the help of Snow, Ice, Hail, Wind, or Nitre, any time of the year; comunicated in the Transactions of July 18. 1666.

Fa pound of powdered Sal Armoniack be mix- Cold produed gradually with three pints of Water, and ced by of the Liquor be stirred with a stick or a Whale-bone; Sal-Armon. whilst the Salt is dissolving, it will produce a and Water. considerable degree of Coldness; which will not only be fensible to the touch; but if it be contained in a Silver Tankard, the outside of it will be covered over with a multitude of little drops of Condensed Vapours, as high as the Mixture reaches.

reaches; and if some of it be quite wiped off, before the Mixture bath lost its virtue, it will a gain be covered over with dew. And if the Ball of a sealed Weather-Glass be immersed in it, the tinged Liquor will presently descend, lower than it did in common Water, and upon a Removal of it into the Air again or common Water, the spirit

will manifestly ascend.

And this Coldness is more or less lasting, as the seasons of the Air contribute to its Coldness, and as the Quantity of the Salt in proportion to the Water is greater or less; or as it varies in Goodness; or as the Salt is put in in grosser Powder, and more leisurely. And the degrees of Cold may easily be discovered, by frequently immerging, and removing a Westher-Glass out of it into Water, and from the latter into it again. Whether Sal Armoniack mixed with Sand or Earth will cool Drink better than without, when the Mixture is sprinkled with Water, I have not yet tryed. But I have found the aforemention'd Mixture cool Liquors conveniently enough after Midsummer.

March 27. A fealed Weather-Glass being immersed in Water, the Spirit that rested at 8 ½ Inches, descended to 7 ½, and then the Sal-Armon. being put in, within a quarter of an hour, it descended to 2 ½ Inches, and before that time, it began to condense the Vapours on the outside of the Glass. And when the frigorisck Mixture was coldest, Water placed this on the outside would be froze in a quarter of a Minute. About 2 of an hour after the Salt was put in, the tinged Liquor being removed out of Water into it, subsided an Inch below





the freezing Mark. At 2 hours after the first Solution it was at 7 Inches, or 4 h, which Mark the Liquor stood at, in hard and lasting Frosts in the Winter. Three hours after the first Dissolution, the Liquor stood at the uppermost freezing Mark. In trying of which Experiment it was observable, that some Water being shed, it froze the Cucurbite to the Table it stood on.

In another Experiment, before the Weather-Glass was put in, it stood at 8 ½, but when immersed in Water it sunk to 7 ½ or ½; in half a quarter of an hour in the frigoristick Mixture it subsided to 7 ½, and in an hour below ½, and consequently within a quarter of

the lowest freezing Mark.

Salt which once hath been dissolv'd, may, by being crystallized in an Iron Vessel, be fit for use again. So March 29, the Thermoscope, which in the Air stood at 8 2, in Water subsided to 8, and in the frigoristick Mixture made of Salt, twice used before, it subsided to 4 Inches; but upon an addition of fresh Water, it rose gradually.

N 2 CHAP.

CHAP. X.

Of the positive and privative Nature of Cold.

fwered.

Argument: D Efore I proceed to enumerate what Argualledg'd in D ments may be alledged either for the posifavour of tive or privative Nature of Cold, I shall briefly nature an- intimate, that the word Cold may be either confidered in reference to the effect fuch Bodies have upon the Senfory, or upon other Bodies: If in the latter, then in frosty Weather the Sun may be faid to warm the Air, because it enables it to melt the Snow, and thaw Ice, as on the contrary, warm Water is faid to be cold in respect of a Hand that is much hotter.

The first Argument.

But to pass on to Arguments in favour of the politive nature of Cold: The first Argument alledged is,. The confiderable Effects it hath both upon the Senfory and other Bodies; fo that we may fumm our Argument up in the words of Gassendus. Ii sunt frigoris effectus, quales babere Privatio, que actionis est incapax, non potest. To which it is answer'd, That Heat and Cold depending only on a greater or less degree of motion of the parts of Matter, than those about our Sensory; and all Perceptions being carried to, and diftinguish'd in the Brain, and being various, as that Motion is different, and it being likewise considered, that when one Body communicates Motion to another, it lofes of its own; it will follow, that when I take a piece of Ice into my Hand, and it is dissolved by the motion communicated to its Parts, the motio d motion which the Humors in my hand lost, by putting those of the Water into motion; induces a sensation of Cold; and consequently there seems to be a privation of that motion which before caused Heat.

Another Argument alledged for the politive The fecond Nature of Cold, is this from Gaffendus. Cum Argument. per byemem immittimus manum in labentis fluminis Aquam, quod frigus in ea sentitur, non potest dici mera privatio, aliudque prorsus esse apparet, fentiri aquam frigidam & fentiri non calidam. Et fac eandem aquam gelari, sentietur baud dubie frigidior; an dices boc effe nibil aliud quam minus calidam sentiri? Atqui calida jam antea non erat, quomodo ergò potuit minus calida effici? To which it is answer'd, That our Sensories may mis-inform us; as when a Stick is partly immerfed in Water, should we judge of it by what appears to our Senses, we should conclude it broke; but our Reason rectifying the Error of our Senfes, we are satisfied it is not : Besides Sensations may depend on alterations in the internal Parts, as well as on the impressions of outward Objects, as in Hunger, Thirst, Coldness in Agues, and Titilation upon venereal Thoughts; besides which Argument, that urged against the former Objection, may be offer'd against this. And fince Water is not fo cold as Ice, it may in a Philosophical Sense be faid to be comparitively warmer, and tho' in respect of the Humours of our Body it be cold, yet by the same reason we might conclude warm Water cold, when the Hand is removed out of hot Water into it.

 N_3

But

A third.

But in favour of the positive nature of Cold, it is further offer'd, that Cold is sometimes introduced into Bodies not hot before.

To which it is answer'd. That fince Fluidity confifts in an agitation of the infensible Parts of a Body, and Heat in a tumultuary one; those Bodies into which Cold is introduced by Congelation, differ whilft they are fluid, only in degrees of motion from Heat; and even when Water is froze it is not absolutely and perfectly cold; fince the Ball of a Weather-Glass being immersed in a Glass of Water, and taken out when the Water was froze about it (the Glass having been before tallow'd over, to make it part with the Ice) the Ice being broken off the Ball of the Weather-Glass, the Air which was colder caused the Liquor to subside. And that there may be sensible Perceptions of several degrees of Privation of the impressions of outward Objects appears, fince we perceive a fensible privation of Light when the Moon is eclipfed nine Digits, and a more sensible one when it is totally darkned.

But tho' I argue for the privative nature of Cold, yet I would not be thought to mean, that an absolute Privation of Motion is the cause of it, and by which it is affected; for I rather think them the occasion, than the efficient cause; the motion of the Blood and Humours being differently modifyed, upon a privation of their motion, and consequently a different Sensation impressed upon the Sensory; and that a Privation of the motion of some Parts of matter about our Sensory may occasion a new Determination of the Motion of those Fluids, may be

inferr'd

inferr'd from easy Observations; for a Tennis-Ball is variously determined in its motion according to the Angle of Incidence upon another Body; and tho' the Arches of a Bridge be quiescent Bodies, yet by throwing the Water together, they render its Stream violent enough to turn Mills; and even the rapid motion of a Bullet may receive a new determination of its motion, by striking upon the surface of the Water, if, when it was first discharg'd, it made a sharp Angle with the Water, so that its Angle of Incidence might not be too blunt; and that various effects may enfue a Privation of some principal cause of former Events, appears further from observing, that by stopping the motion of Water, a Mill presently ceases to move, tho' no politive violence be offer'd to it : And upon a relaxation of the violence of Wind, all that was perform'd by the Mill presently ceases for want of Wind: And in Paralytick cafes, a viscous or narcotic Humour obstructing or disaffecting one part of a Nerve, so that Spirits cannot freely circulate through it, occasions several odd and terrible Symptoms: And Animals included in an Air-Pump dye barely by a privation of Air, tho' nothing elfe is prefent to disaffect them. And even Insects, tho' void of motion upon a privation of Air, yet when it is again let into them, they move about as the advantages of their Species enables them; so that from what hath been said it appears, that a privation of the Agitation of the Humours may occasion a contrary, and probably the effects ascribed to Cold.

N 4

The

A fourth.

The next Argument alledged by Gaffendus and to be considered is this. Fac manuum immitti in aquam nunc calidam, nunc frigidam, quamobrem manus intra istam, non intra illam refrigeratur? An quia Calor manus intra frigidam retrabitur, manusq; proinde relinquitur calida manus? At quidnam calor refugit, quod intra frigidam reperiatur nonne frigas? At fi frigus est Tantum Privatio, quidnam calor ab illa metuit? Privatio sane nibil est, atq; adeo nibil agere, unde ejus motus incutiatur, potest. But without supposing insensible matter to be in the least capable of proscecuting or avoiding what is hurtful to it; this Objection is easily answered; for the Reason why warm Water feels hot; and cold affects us upon immerging our hand in it, is, because the Parts of the one is more, and the Parts of the other less agitated than those about the Sensory, and the motion of Humours about our Senfory; being increased we feel a hot fensation; and a cold one upon a Privation of that motion.

A fifth.

And tho' it be urged by some in favour of the positive Nature of Cold, that Water is froze by externally applying to the outside of a Glass a Mixture of Snow and Salt; yet to shew that Argument proves not that Cold acts positively, I shall add the following explication of des Cartes. Quia materia subtilis, partibus bujus aqua circumfusa crassion aut minus subtilis, & consequenter plus virium babens, quam illa qua circa news partes berebat, locum illius occupat, dum partes nivis liquescendo partibus salis circumvolvuntur. Facilius enim per salsa aqua quam per dulcis poros movetur, & perpetuo ex corpore uno, in aliud transire

transire nititur, ut ad ea loca perveniat in quibus mortui suo minus resistitur, que ipso materia subtilior ex nive in aquam penetrat, ut egredienti fuccedat, & quum non fatis valida fit, ad continuandam agitationem bujus aquæ illam concrescere smit. And in a similar manner Calces or Precipitates, or other Powders, are dryed by being placed on a piece of Paper, not that that acts positively upon them, but imbibes the moisture. And I have seen a Cold Liquor acquire a hardness, its moisture being imbibed by a piece of Bread immersed in it; as also Spirit of Wine dephlegmed by a Mixture of Salt of Tartar, without so much as Heat, the Aqueous Parts finding a more ready and easie passage into the Pores of the Alkaly, than through the Spiritous Liquor. And I know a faline Body, which when incorporated with Water, the Water will leave this a confiftent mass, and be imbibed by the Spirit of Wine. And for a further illustration of the Cartesian Explication, I shall add, that Camphire by floating upon Aqua fortis will become a fluid Oyl, and continue in that form till the fubtle Spirit, which, by pervading it, kept it fluid, flyes away and evaporates; for being put into Water, the Spirit leaving the Camphire, and being imbibed into the Pores of the Water, it becomes a confiftent mass again, which, that it depended not on the Coldness of the Water was evident, fince the fame would happen on warm Water. But tho'Cold should depend primarily on the influence of frigorifick Atoms, yet fince those by acting on the Body cooled, may produce their effect by expelling calorifick Atoms, the privation

privation of those calorifick Atoms, is the cause of freezing; so the a Bullet kills a Man, yet the issue is a privation of life; and when a Room is darkned by extinguishing the light, the darkness depends on the privation of light.

A finh.

The last Argument of Gassendus is this, Tamets multa videantur ex sola caloris absentia
frigescere, nibil ominus nist frigus extrinscus inducatur, non tam profesto frigescere quam decalescere sunt Censenda. Esto enim Lapis, Lignum,
aut aliquid aliud, quod nec calidnm nec frigidum
sit, id ubi fuerit ad motum Igni calesiet sane, at
cum deinceps calor excedet, neq; frigidum ullum
circumstabit, non erit cur dicas ipsum frigesieri,
potius quam minus calidum sieri rediere in suum
statum.

But to this it may be answered, that if we speak of Coldness with respect to sense, I see not why any Body that grows hot by the action of the fire may not be said, to grow Cold rather than Decalescere, since Heat being only too brisk an agitation for our Sensory, when upon a removal of that Cause, and a declining of that motion, it became less agitated than the Humours about our Sensory, we may not then say it grows Colder and Colder till it become

Ice.

But to conclude this Chapter, I shall add, that the I have offered these Arguments against Gassendus, yet I shall wave determining the Controversie till further satisfied in some Speculations, and in the Phænomena of some Particular Experiments; besides I would first know, from those that would have Cold to be

a positive Quality, whether and on what account those little fragments of matter are Cold, Whether their frigorisick Atoms have weight? As also what is their Texture, and whether that Quality may be destroy'd; and whether they be primitive Bodies or not? And why Coldness ensues the Mixture of two warm Bodies. And in order to the solving of some of which it would be requisite to enquire, how Water comes by its expansive force upon congelation? And since Cold is a Privation of motion, why upon the Mixture of certain Bodies Cold ensues, tho' their Parts be thereby put into motion.

CHAP. XI.

Two Problems about Cold. An attempt to measure the great expansive force of freezing Water: Of the Production of Cold by the conslict of Bodies appearing to make an Ebullition.

THE first Problem I shall propose is; bow The upon the Mixture of two or three Bodies, there should ensue a great and tumultuary agitation of small Parts, and yet even during this conflist, not any sensible Heat; but a considerable degree of Cold be produced. Concerning which I shall only propose the question, whether local motion be not Generical; and whether the sigure and size of Parts variously moved may not be able to cause a sensation of Heat, and when variously modify d, a sense of Cold; or whether the sense of Cold depends not on some frigorisick Atoms

The first Problem. Atoms which are let lofe in the Ebullition and affect the Senfory, which would otherwise perceive a hot sensation by the effects of the motion of those Parts, with which cold Aoms are mixed, and which they over-power.

The second Problem.

The fecond Problem is, Whence the vast force of freezing Water proceeds? For fince Cold depends on an Imminution of local motion; it is not a little strange how it should be able to break refifting Bodies, which require local motion to separate their Parts. And tho' Gassendus tells us, that they proceed from the ingress of frigorifick Atoms; yet till Glaciation fucceeds, notwithstanding Water grows colder gradually, it fublides and does not expand: And Spirit of Wine, and Chymical Oyls, the greater degree of Cold they are exposed to contract the more; and some Oyls even when coagulated are condensed instead of being expanded. And as for what the Cartesians offer for the removal of these difficulties, it may well be questioned how their Eel-like Particles being relaxed and their fpring weakned, they should be able to expand in spite of Opposition. So that considering that Water when expanded is full of bubbles, I was apt to suspect, that the Air contained in them contributed to the effect, and that a constipation of the Pores of Water might give them a springiness.

The great expansive ter froze.

To try the expansive force of freezing Water, we convey'd a Bladder full of Water into a force of Wa. Brass Cylinder, and fitting a Plugg to it, upon that we placed a flat Board to hold Weights on, and then the Cylinder being encompassed with a frigorifick Mixture, upon the freezing of the Water, in one Experiment the Plugg raifed 114 pound, weight and in another 100 pound Averdupois, and in a third 254 pound

weight.

Three faline Bodies, each purify'd by the Of the Profire, being mixed together, produced a cold dustion of Effervescense with a hissing noise and a consi- Cold. derable Intumescense. And in the mean time the Glass which contained it would grow colder than before, and gather a Dew on the outfide, which would reach as high as the Mixture; but on the concave bottom of the Glass there was no Dew, that being not sufficiently exposed to the Air; so that the Mixture could not be supposed to sweat through the Pores of the Glass, fince it tafted not in the least of faline Ingredients : But least our Senfes should misinform us of the degrees of Cold, in this Mixture, we at another time immerfed a Weather-Glass, in which the Liquor subsided above four Inches lower than in common Water. Tho' the Acid Liquor it felf, being kept all Night in a Room with Water, was of the fame temper with it, which appeared by a Weather-Glass immersed in both successively. And the Salt it felf being cast into Water scarce made it sensibly colder; nor did the Glass wherein this Salt was kept disclose any remarkable degree of Coldness. And even the frigorifick Mixture it felf, when the Ebullition was over, appear'd not colder than common Water in a Night's time; fo that the Coldness depended purely upon the Texture of the fermenting Liquor.

And to this I shall add, that the' I made use of a Spirit that was drawn off at the same time with this Salt, and which in the Judgment of my fenses appeared to be of the same kind, yet inftead of a cold Ebullition, it produced a Luke-warm Heat. And to thefe I shall further fubjoyn, that tho' the Liquor above mention'd would produce a cold Ferment with the dry Salt, yet with the Spirit it grew warm; tho' some of the same frigorifick Spirit kept warm by the fire till the Liquor in the Weather-Glass rose, yet upon the injecting of some of the dry'd Salt it would be manifestly depressed, Nay, tho the Spirit and Salt were both warm, yet upon their Mixture they would produce a manifest Coldness.

And to this Experiment I shall add, that Salt of Tartar mix'd with Spirit of Vinegar produced, upon their Ebullition, a degree of Coldness greater than that of Water, and when a Weather-Glass was removed out of Water into it an hour after the ferment, the Spirit was depressed about half an Inch; tho' Salt of Pot-ashes mix'd with Spirit of Vinegar produced Heat, as appeared by the same Weather-Glass succes-

fively immerfed in either.

CHAP.

CHAP. XII.

Of the Mechanical Origin or Production of

TEAT being a quality whose nature seems of the mato confift in a mechanical Motion of the chanical Parts of the Body faid to be hot, it may be re- of Heat. quifite to note, that the three following Conditions are necessary in modifying that Motion.

First, That the Motion be more rapid than in Bodies barely fluid; fo Water becomes hot by an increase of the motion of its Parts, which argue their vehement motion by dissolving Butter, and rising in the form of Vapours: Which effects are more conspicuous as the degree of Motion is greater or less. Another Instance to shew that the Parts of hot Water are in a more violent agitation than those of cold. is in Water cast upon a hot Iron; for they prefently acquire such an additional Motion from that hot Body, that it hisses and boils, yielding Steams copiously. But a stronger instance of the vehement Agitation of the parts of hot Bodies is in actual Flame, fince they move fo impetuously as to dissolve and shatter whatever lies in their way.

A fecond Condition requifite to render a Body hot, is, that the motion of its Parts be varioully determined; which variety of Determination is apparent in Fire, which produces the same effects on the same Bodies, whatsoever is their Scituation in respect of that Fire; so a red

Coal melts Wax, whether held above, below, or on one fide of it; and that a variously determin'd Motion is requisite, appears, if we observe that the rapid motion of Water in a River which is only one way, contributes not to the increase of its heat.

A third requisite is, that the Parts in such a Motion should be very minute, so as to be infensible; since it is manifest, that the Sand be put into a violent motion, it acquires not a

heat by it.

fortis upon Silver.

This account of heat being considered, it will appear, that a Body may become hot as many ways as it is capable of having its parts put into such a Motion: To illustrate which Observation, I shall subjoin some instances of the Production of Heat several ways; as first by an essential of the production of Oyl of Vitriol upon Salt of Tartar, A.

But to pass over these common Instances, I shall proceed to some not so frequently known, having first taken notice of the Heat which succeeds an effusion of cold Water upon Quick-lime, which Phænomenon, tho' it be commonly held to be an effect of an Antiperistasis, upon the enclosure of the Lime in cold Water, yet that the effect is produced by another cause appears, since the like succeeds if hot Water be made use of instead of Cold; and surther, because, tho' Oyl of Turpentine be poured on it cold, no such Effect follows.

EXPE-

EXPERIMENT I

Tho' Helmont ascribes the Incalescence of Quick-lime upon an Affusion of Water, to a conflict of an Alkalizate and an acid Salt, fet at liberty by being disfolv'd in the Water; yet fince no fuch acid appears to be latent in Quicklime: the account is unfatisfactory : For I might as well suppose an Acid latent in other Alkalies, in as much as Salt of Tartar mixed with Water, either in the Palm of ones Hand or in a Vials affords a fensible Heat.

EXPERIMENT II, III, IV.

Others think that the cause of the Heat of Quick-lime proceeds from some flery Empyrumatical Atoms lodged in the fubstance of the Stone; when calcin'd, and fet at liberty in the form of Effluvia; but this Hypothelis is not without some difficulties, fince no such Heat succeeds an affusion of Water upon Minium, or Crocus Martis per fe, tho' their increase of weight argues that they are stuffed with fiery and metalline Particles: To which I shall add; that I knew two Liquors, which being feveral times separated, and reconjoined without addition, did at each Congress acquire a sensible heat; fo Salt of Tartar feveral times freed The effects from Water, will produce Heat when mixed of a mixagain with that Water; which shews that the fure of Salt violence of the Fire is not requisite to impress and Water. upon all calcin'd Bodies that will heat with Water, what pailes for an Empyreum. And this Phenomenon I am apt to believe proceeds from

a disposition of the Texture of the Salt being flocked with store of igneous Parts, which upon an ingress of Water presed into the Pores of the Body, by the weight of the Atmosphere are apt to break the Texture of that Body, and m put them in motion, fo as to produce a fenfible Heat. And that the Ferment depends up on the peculiar Texture of the Salt, I am perswaded, and a constipation of the Pores of it: fince Sal-Armon, disfolv'd in Water and boiled to a dry Salt, was not fo much impregnated with fiery Parts, as to cause a Heat upon its mirture with Water again, but a considerable degree of Cold; and tho' one would exped: greater cognation betwixt the Particles of fire adhering to Quick-lime, and Spirit of Wine wholly inflammable; yet the latter poured upon the former did not produce any fensible incalescence, or dissolution of it; and when this Spirit was foak'd into it, I poured Water upon it, without perceiving the least Heat or the Lime broken, till within a few hours after; fo that the Spirit being fucked into the most capecious Pores of the Lime, and affociating with the Water, rendred it more unfit to penetrate the minuter Pores, and to dissolve the Lime.

EXPERIMENT V.

Quick-lime being immersed in Spirit of Wine in a Retort, and the Spirit and Phlegm drawn off, the remaining Quick-lime, instead of being slacked, was a more fiery substance than before, for if a piece of it was thrown into Water it would his like a Coal, and heat the Liquori

quor; which property it retained feveral weeks, being kept close from the Air. Whence it appears how much the Texture of Quicklime, and the affociation of the Spirit of Wine improving that Texture, contribute to the Phenomena offorded by Quick-lime; and that the Spirit of Wine was affociated with the Quick-lime is probable, fince Part of it became a Spiritless Phlegm; and I have observ'd. Quick-lime and Spirit of Wine sometimes to come over in white fumes: To which I shall add, that in fuch distillations the Odour of the Spirit hath not only been changed, but its tafte rendered more fiery, and brisk: But the fuccess is not always the same; being diversified according to difference of the Quick-lime, which may be more or less calcined; or the stone may be of a different nature it felf.

EXPERIMENT VI.

But to proceed to other Experiments which shew, that Heat may be produced mechanically. A nail hastily hammered grows hot, the Parts of the metal being by that force vehemently and variously determined; tho' the hammer and Anvil be not warm; so that hence it appears, that it is not requisite a calorisick Body should be hot it self, the Hammer being able, tho' cold, to warm the Iron it beats upon; and so the head of a nail grows hot, when it can pierce no deeper into wood, the force of the beating Hammer being not spent in depressing the nail, but putting the resisting Parts into significant.

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EXPERIMENT VIL

And once I caused a piece of Iron to be beaten by three Smiths, till it grew so has as to kindle Sulphur upon it.

EXPERIMENT VIII.

And that Heat may be produced by percufion and attrition appears further, fince Iron grows hot by being boiled, a knife by whetting, a Brass nail by being rubbed, and flint by being struck together.

EXPERIMENT IX.

To shew that Heat may be produced without the attrition of contiguous Air, I placed pitch under Water; and by the Sun-beams cal into a Focus by a burning Glass upon it, it we not only melted, but seemed to boil and smoak.

EXPERIMENT X.

The Powder of flacked Quick-lime, walled from its Salts, being mixed with Sal-Armonian and melted together, the cold mass being put into a Glass, upon an affusion of Water, grew too hot to be touched with ones hand, tho' the Sal-Armoniack it self in Water produces Cold.

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EXPERIMENT XI.

Sal-Armoniack and filings of Steel being sublimed together, the Caput Mortuum in which the greatest Part of the Salt remained, instead of increasing the coldness of Water, being poured upon it several Months after the Caput Mortuum was first laid up; gave the Water a notable degree of Heat.

EXPERIMENT XII.

Equal Parts of Antimony and Sal-Armoniack being sublimed with several degrees of Heat in a Glass-Vessel, we obtained three several substances; which being severally powdered; the Caput Mortuum which was like Antimony, being put into Water in which a Thermoscope was immersed, scarce raised the Liquor sensibly: But the yellow sublimate which consisted of the Sulphureous flowers of Antimony and the more Volatil Salts of the Sal-Armoniack. caused the Weather-Glass in another parcel of Water to descend a quarter of an Inch, and the lower fublimate which was black, being put into a third parcel of Water the Liquor in the Weather-Glass subsided near three Inches. But the like Experiments being tryed with the Caput Mortuum of Minium and Sal-Armoniack, it neither caused the Liquor in the Weather-Glass to rife or fall; but the sublimate raised from these ingredients, caused the Liquor to subside a little.

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EXPERIMENT XIII.

Whether Solvents dissolve Minerals, and cause that Heat observable in their Action, by any Antipathy betwixt the Mineral and the Mon-Gruum, or whether it did not rather proceed from the violent agitation of the parts of the Metal, either dissolv'd by the infinuation of its parts into the Pores of the Metal, or by oblimeting the passage of some athereal Matter through those Pores, which wanting its usual course dissolves the Metal, by forcing a new way, I shall not undertake to determine; but having agitated Oyl of Vitriol with four time its weight of Water, thereby it obtained a fensible Heat; from which Experiment it appears, that the Heat produc'd by Minerals depends not on a conflict of Acid and Alkalia, fince Water is void of either of those chymical qualities.

EXPERIMENT XIV.

If a piece of wet Ice be thrown into a Viol, which before contained Oyl of Vitriol, the Oyl mixing with the Water dissolves the Ice, and causes a strong Fermentation, and a violent Heat.

EXPERIMENT XV.

Half an ounce of Spirit of Wine being mixed with an ounce of Oyl of Vitriol, acquired a confiderable degree of Heat presently, and almost



most filled the Bottle with Fumes; and the Bottle grew so hot at the last that I could not hold it in my Hand. The like Succeeded, only in a more remiss Degree, with common Brandy; and also with Aqua Vita.

EXPERIMENT XVI.

Tho' the Chymists teach, that the Incale-scence of Bodies depends on an Antipathy of the mixed Bodies, yet I found an intense Heat ensure the Mixture of Parts of the same Bodies; viz. Calcin'd Colcotbar, and Oyl of Vitriol.

EXPERIMENT XVII.

Oyl of Vitriol and Oyl of Turpentine mixed together, produce a considerable degree of Heat.

EXPERIMENT XVIII.

An ounce of rectify'd Petroleum being mixed with an equal weight of Oyl of Vitriol, the former Liquor seemed to work upon the surface of this, like a Menstruum upon Metal; the Fumes of the Oyl of Vitriol rising into the Ol. Petra; and the mutual re-action of both the Liquors caused a moderate Warmness. And we had almost the like success with Petroleum, and Spirit of Nitre. But in these last mention'd Tryals, Spirit of Salt made use of instead of Oyl of Vitriol had no such considerable Estects.

EXPERIMENT XIX.

Oyl of Vitriol caused a considerable Effervescence upon Filings of Steel; especially if they be soaked in Water: And it will grow sensibly hot with Lime, Oyster-shells, Chalk, Lapis Calaminaris, &c.

EXPERIMENT XX.

Oyl of Vitriol grows hot with Cherries, and likewife with Raifins of the Sun beat in a Mortar, as well as with feveral other Vegetable Substances, and very considerably with Crumbs of white Bread.

EXPERIMENT XXI.

Oyl of Vitriol canses a considerable Heat if mixed with minced Flesh.

EXPERIMENT XXII,

Tho' Sea-Salt imparts a Coldness to Water, yet with Oyl of Vitriol it causes Heat; yet with Sal Armon. part of which consists of common Salt, it produces a Coldness.

EXPERIMENT XXIII.

Common Sulphur acquir'd a Heat by attritition, and emitted fulphureous Steams copiously; fo that Sulphur it self, as well as other Bodies, ows its Heat to local Motion.

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EXPERIMENT XXV.

Equal parts of Sal Armon, and Quick-lime being fluxed together, an ounce of the Powder put into Water, caused a violent Heat, tho's Sal Armon, it self produces Cold.

EXPERIMENT XXV.

We observ'd that beaten Sublimate being mix'd with powder'd Antimony, after it had stood some time in the Air, the Mixture grew sensibly hot, which Phanomenon I attribute in part to the Moisture imbibed from the Air, since it is requisite to make the Experiment succeed, that it should be exposed in a moist Cellar.

EXPERIMENT XXVL

Tryals have affured me, that in Summer, fine Sulphur and Filings of Steel being mixed together in Water, will grow intenfely hot, if firred about an hour after they are mixed; and will likewise emit Steams copiously.

EXPERIMENT XXVII.

Several Tryals have convinc'd me, that a Mercury may be so prepared as to afford an Incalescence with Gold.

EXPERIMENT XXVIII.

Having distill'd from Quick-silver four times its weight of Oyl of Vitriol, and by that means reduced it to a Powder, which upon the account of the Salts of the Menstruum was white and gliftering, and being put into Water in which a Weather-Glass was immersed, it canfed the Spirit to rife manifestly; which is the more remarkable, because Helmont observes that the Salt adhering to the Mercury, corroded in a good quantity, by Oyl of Vitriol, if it be washed off and coagulated, becomes a kind of Allum. And this Phanomenon is still the more remarkable, because Vitriolum Martis made with Oyl of Vitriol and Filings of Steel, being put into Spirit of Wine, was not impelled up as by the former Mixture, but after a while rather subsided. Common Sublimate dissolved in Water, neither sensibly depressed or raised the Spirit of Wine.

CHAP

CHAP. XIII.

Of Mercury growing hot with Gold, communicated in the Transactions of Feb. 21: 1678.

TAving obtain'd a Mercury fine and clean, of Mercary and even purged by Sublimations and Difillations, and incorporated a multitude of heterogeneous Particles with it, so that they could not be discovered, and much less separated, except by a skilful Artist; I mixed sometimes half and fometimes an equal quantity of Calx of Gold with this Mercury, in the Palm of my Hand, stirring and pressing it with the Finger of my other Hand, by which means the Ingredients being mixed, they grew fenfibly hot in a Minute; and I observ'd, that when they were mixed in equal quantities, they would produce a much greater degree of Heat, than if their Proportion was not exact. And the like success ensued, when the Mixture was preferved from being contiguous to the Skin, by being contained in a piece of Paper, laid betwixt my Hand and it; and the fame succeeded in the Hands of other Persons. But with Silver, it would not produce an Incalescence.

But tho' this Mercury grows hot with Gold, yet I much question, whether, as Chymists call them, Mercurii Corporum, made by extraction from Minerals and Metals, will grow hot with Gold, as I found Antimonial Mercury did. And I am far from affirming, that that which is called Philosophick Mercury, or even those obtain'd

tain'd from Gold and Silver are fitter for such pies, than common Mercury skilfully purged and impregnated with the subtle and active Particles of congruous Metals and Minerals.

To what hath been said of this Mercury, I shall add, that it preserves its quality of growing hot with Gold two or three Years, and the it be distilled from Gold again and again. And whereas its usual to take eight or ten parts of Quick-silver to make an Amalgama with Gold; this Mercury would do it, being used in an e-

qual Proportion.

As for the manner of preparing this Mercury. I don't think it convenient to publish it, only this I shall fay, that it may be made more ways than one, and without employing Antimony, or fuch folid Metals as Mars, But that of ours, I observ'd, succeeded best, in the production of Heat, by being mixed with Quercetanus's Calx of Gold, viz. by melting Gold with three or four parts of Silver ; for by putting this into Aq. foris the Silver will be disfolv'd, and the Gold remain in the form of a But lest an Incalescence, produc'd by fuch a Calx, should be supposed to proceed from faline Particles of the Aq. fortis working on the Quick-filver, I shall add, that it will not produce such an effect on common Quick-silver ; but ours will cause an Incalescence even with pure Leaf-Gold.

CHAP.

CHAP. XIV.

New Experiments to make Fire and Flame ponderable.

EXPERIMENT L

A Thin Plate of Copper being placed in a Crucible, which had a Hole on purpose in the bottom of it, this Crucible was inverted into another, which contained slaming Sulphur, so that the Copper-Plate was exposed to the Flame of it. In two Hours the Sulphur being consum'd, the Copper-Plate was manifestly swelled; and tho' its Weight at the first was but a Dram and a half and twenty five Grains, yet it became thirty two Grains heavier, which is about a fifth part above its former Weight.

EXPERIMENT II.

Refined Silver being placed over the Flame of Sulphur after the same manner as the Copper was, in an Hour and a half weighed one Dram five Grains and three quarters; its weight before being a Dram wanting two Grains. Whether it depends on the closeness of the Metal, and incongruity of the Pores, that Silver acquires not proportionably so great a weight as Copper, I shall leave to the Reader to consider: But from these Experiments it appears, that the Corpuscles of Fire, like other Menstruums, may be united with the Bodies it works upon.

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EXPERIMENT III and IV.

An ounce of Copper Plates, being kept in a shallow crucible in a Cupelling Furnace two hours, weighed thirty grains more than before. But an ounce of filings, in three hours time; were caked into a lump, and weighed forty nine grains more than before.

EXPERIMENT V.

Calcined Harts-horn, and an ounce of Brick; being two hours in a cupelling Furnace, the latter neither increased or lost of its weight, but being exposed to the Air in a scale, by imbibeing the moisture of the Air, in a little time caused it to preponderate; but the Harts-horn lost near eight grains of its former weight; which I supposed to be caused by an Evaporation of some moist Particles of the Air, because by being exposed to the Air a while, it increased in weight again.

EXPERIMENT VI and VII.

An ounce of Tin being calcined in a Cupel under a Mouffler, in two hours had gained a dram in weight. And an ounce of Lead placed upon a Cupel made of calcined Harts-horn was turned into a litharge upon it, and the Part of the Cupel was loft in the fire, yet the Lead and it weighed seven grains more than before.

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EXPERIMENT VIII.

A Cupel made of ten Parts of Bone-ashes, and one of Charcoal-ashes, with a sufficient quantity of Ale, weighed about two ounces, and this being placed under a Mousser, and weighed again when it was throughly hot, it weighed two grains more, but being kept under the Mousser two hours longer, and then weighed whilst red hot, it had gained twenty one grains in weight, and by being exposed a while to the open Air, it grew three grains heavier than before.

EXPERIMENT IX, X and XI.

Four drams of filing of Steel, in two hours increased in weight one dram, six grains and a quarter. A piece of silver, which before weighed three drams thirty two grains and a quarter, in an hour and a half increased to 34 I grains. Another time half an ounce of filings of silver in three hours gained six grains. A drachm of Zink or Spelter in three hours gained six grains.

EXPERIMENT XII.

Two drams of filings of Tutenag, a metal brought from the East-Indies, being kept upon the Cupel two hours, was not melted into lumps, but looked like Cerus and Minium powdered and mixed together, some Parts appearing white

white and others red, the Calx being weighed had gained 28 # grains:

EXPERIMENT XIII.

Lead that is usually employed about them, flyes away in smoak, we heated a Cupel and weighing it placed two ounces of Lead and a drachm of filings of Copper upon it, and after it had been two hours in a Cupelling Furnace, tho nothing appeared upon the Cupel, worth weighing distinctly, yet weighing the whole together, they amounted to four ounces three drams and eleven grains, which wanted but nine grains of the whole weight of the Cupel and metals, so that allowing for what the Cupel it self might have gained, the greatest Part seemed to be sunk into the Cupel.

EXPERIMENT XIV, XV and XXI.

To shew whether metals separated from an immediate contact with the fire would have their weight increased by it, we included an ounce of filings of Steel in two Crucibles luted together, and in two hours being taken out, they had acquired a dark colour; betwixt black and blue, and were increased in weight five grains, and this Experiment being repeated they gained six grains. Two ounces of Copper in an hour and half gained eight grains, the like quantity of Tin being partly reduced to a white Calx, and partly melted in a yellow lump like Gold, it had gained fix grains in weight

weight. But an ounce and four drachms of this Copper being a second time exposed for two hours to a strong fire in two Crucibles as before, gained ten grains more in weight, and had divers dark coloured slakes upon the Metal, which upon handling, for the most part, sell off. Adrachm of Tin being mixed with two ounces of Lead, tho' at the first the mass was dry at the top, and seemed swelled and discoloured, yet Tin gives Lead such an Indisposition to Cupellation, that it answered not our Expectation.

EXPERIMENT XVI, XVII and XVIII.

Copper being made use of which consisted of thinner Plates than the former, an ounce increased twenty one grains in weight. Half a pound of Block-Tin being kept in Fusion in a Glass-Retort placed two days in a sand Furnace, it increased about two grains in weight. I tryed likewise to make a Precipitate of Mercury per se in sealed Glasses, but either by their breaking or other Inconveniences, it answered not my design.

EXPERIMENT XIX and XX.

A Calx of Tin per se which weighed an ounce, being kept upon a Cupel under a Mouffler two hours, gained in weight one drachm and thirty five grains, and became much whiter than before. No Part of the Putte was melted, much less reduced into Metal. An ounce of filings of Steel.

Steel, which had been before exposed to the fire increased in weight two drams and twenty two grains; the filings being baked together, and when broke appearing like Iron.

CHAP. XV.

Additional Experiments about arresting and weighing of igneous Corpuscles.

EXPERIMENT I and II.

E IGHT ounces of Block-Tin being cut in pieces and put into a good round Vial, with a long neck, and being cautiously melted over Quick-Coals, the Glass being frequently shaken, to promote Calcination, near an hour, the neck of the Vial being most of the time preserved from the steams of the Coals with a cover of Paper; the Tin which was partly calcined, increased eighteen grains in weight. This being done we melted the remaining metal into thin Plates, by which Operation, it lost three grains of the eighteen it had got; but being a fecond time exposed to Calcination in another Vial, it afforded a much greater Quantity of it than before, and increased in weight to eight ounces and twenty four grains. In which Tryals it is observable, that agitation much contributes to the Calcination of Metals.

EXPERIMENT III, IV, V.

Eight ounces of Tin being exposed to calm cine in a Bolt-head Hermetically fealed, the Glass flew in pieces, and a yellowish Liquor which was of an odious taste and smell, was found in the neck. But the Experiment being a fecond time repeated, the Metal being fuffered to cool, before the Glass broke, the weight was twenty three grains more than before, tho the whole Calx amounted to no more than four scruples and eight grains: The top of the Metal was very asperous and of a dark colour, tho' the neighbouring Surface and some places near the dark colour'd Calx, which was between the bottom and lowest part of the lump, was of a Golden colour by candle-light. Two ounces of filings of Tin being exposed to Calcination two hours in a small Retort, at the first several steams issued out at the small Apex of the Stem, but then the Apex being fealed up, a yellowish clammy substance thinly spread and which smelled like fetid Oyl of Tartar, was gathered in the neck; and the Glass being broke, the lump of Metal which was in some measure covered with a gray Calx, weighed twelve grains more than before.

EXPERIMENT VI and VII.

An ounce of filing of Zinke being kept in a Bolt-head four hours over live Coals; fumes copiously were emitted out of the unstoped Apex of the Stem; and the whole remaining

Zinke,

Zinke, and the flowers which had ascended being weighed, wanted five grains of an ounce. But four ounces of Lead being enclosed in another Retort, it was held over a fire two hours; and then the Apex which was small being sealed up, the Glass was exposed to the fire two hours longer; in which time the Surface of the melted metal was dark and rugged, and Part of it was turned into a dark coloured Calx. The Lead being weighed had gained about thirteen grains in weight.

EXPERIMENT VIII and IX.

Pieces of red Coral being exposed to the fire, till of a dark colonr, gained three grains and a half in weight. Fresh and strong Quick-lime being placed upon a Cupel two hours, and which before weighed two drams, encreased in weight twenty nine grains. From whence it appears, that tho' Lime hath been before exposed to the fire, yet it is capable of having more igneous Corpuscles united with its Substance; from whence we may infer, that tho' Lime-stone by calcination hath lost much of its weight, yet it may have recieved a considerable addition from the fire, which may in Part make amends for those Corpuscles which have flown away; upon which account it may be uncertain in other Bodies, which we have made Tryals with, how much weight they have truly received from the fire, fince it is uncerain how much of their first weight might be loft in Exhalations.

CHAP.

CHAP. XVI.

A discovery of the Perviousness of Glass to ponderable Parts of Flame.

I

EXPERIMENT I.

O shew that Glass is Pervious to the ponderable Part of Flame, I shall to the Experiments already laid down fubjoyn. That having fixed a fmall Pan which contained Sulphur, upon another which contained Coals, to continue its Flame; I contrived it fo that nothing but the Flame of the Sulphur should come at the Retort, and that the fire and smoak of the Coals should be carried off another way, which being done, two ounces of filings of Tin were Hermetically scalled up in a Retort, and the Glass being gradually exposed three hours and a half to the Flame of the Sulphur, there was a good quantity of gray Calx at the bottom, and upon some Part of the Metal. In which Operation, it gained four grains and a half. And the Experiment being again repeated, the Metal acquired eleven grains and a half. that it may not be thought that the increase of weight depended upon Particles of Glass disfolved and fixed upon the Calces, I shall add, that I feveral times exposed Glasses to the fire without perceiving any considerable alteration in the weight of the Glass.

EXPERIMENT II.

Tho' common Sulphur be a Body homogeneous enough, confifting of inflamable Parts, and an acid near a-kin to Spirit of Vitriol; yet to vary the Tryal, I made use of inflamable Spirit of Wine, over the Flame of which, a Glass Retort with an ounce of Tin was held for two Hours; the Calx being considerable in quantity, was weighed, together with the remaining part of the Tin, which was hardned into a Lump, and it appeared that it had increased its weight four grains and a half.

EXPERIMENT III.

An ounce of Lead being sealed up in a Retort, and exposed to the Flame of Spirit of Wine, seven scruples were turned into a gray-ish Calx, which being weighed again with the rest of the Metal, it appeared, the increase of Weight was six grains. NB. But lest it should be thought, that the Particles of the Flame, which increased the weight of the Metal, were turned into Metal, I weighed the Calces in Air and Water, and sound, that whereas Lead is to its Bulk of Water as 11 to 1, this Calx was but as 9 to 1.

From which Experiments it appears, that Metal receives an increase of Weight from Flame, and that too, through the Pores of Glass. But tho' I believe that Glass is penetrable to the Parts of Flame, yet I am far from thinking that

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it is pervious either to Chymical Liquors, Quick-

filver, or Air.

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And this I shall add, that it may be worth while to consider, whether all the parts of Fire are fine enough to penetrate Glass, fince Metals ecquire not fo much weight when shut up in Glasses, as when exposed to the open Fire. And it may be likewise consider'd, whether the Pores of Glass are naturally large enough to give way to the Fire's igneous Particles, or whether their Heat and rapid Motion does not enlarge the Pores of the Glass, and contribute to their Penetration of it: Por I know a Menstruum, which will not work upon a Metal whilft cold ; but when hot it will reduce it to a Powder. And on this occasion I shall add, that 'till I am further satisfied, I shall forbear to determine, whether the Rectitude of the Pores of Glass contributes to the Perviousness of it, and whether metalline Vessels are pervious to the ponderable parts of Flame, or not. Having hid down these doubts. I shall thence deduce the following Corollaries.

COROLLARY L

Confirming the Parodox, That Flame may all as a Menitroum, and make Coalitions with the Bodies it works upon.

From the Experiments laid down it appears, that Flame is capable of acting as a Menstruum, not only in disloving, but by associating with the Parts of the Body it works upon, and thereby to add Substance and Weight to them; and

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tho' it renders not Lead and Tin liquid, yet it may still be accounted a Menstruum, it not being a constant property of a Menstruum to dissolve the Body into a liquid; since Tin dissolved in Aqua fortis remains in the bottom in the form of a white Calx. And when Oyl of Vitriol is drawn from Quick-silver, it leaves the Mercury in the form of a white Powder, but a small Part of which, will be dissoluble in Water. And one thing observable in this Menstruum is, that whereas other Menstruums are several times the proportion of the Body dissolved, in this, the Corrosive makes but a twentieth part of the Body corroded.

COROLLARY II.

Proposing a Paradox about Calcination and Calces.

From our Experiments it appears, that Bodies may be calcin'd, without having the greatest part of their Substance driven away, and only the Caput Mortuum, and some fixed Salts; remaining behind, as the generality of Chymists and Philosophers teach; fince it is evident, that in our Tryal, no confiderable Particles flew away, but that the Metal gains more than it lo-And hence we may have reason to judge of the erroneous opinion of those who suppose Saccbarum Saturni to be the sweet Salt extracted by the Spirit, whereas it appears, that it plentifully concurs in the Composition of it; fo that from hence it appears, that the Calx of a Metal, may be in some cases not the Caput Mortuum or Terra damnata, but the Magistery of of it, fince the bulk of the Body is preserved, and it only, with a Solvent acquires a new form. And I have elsewhere made it appear, that the dry Calx of Lead may be turned into a malleable Metal again, without Flux-powder, or any other Additament.

COROLLARY III.

From the foregoing Trials it likewise appears what will become of the Epicurean and Cartesian Doctrines of Fire; the one teaching, that tho' Fire may penetrate Glass, yet it passes through Metals, without being arrested by them; and the other, that igneous Particles cannot penetrate Glass.

Whether Fire is arrested in Meat as it roasts or not, I shall not undertake to determine; but if it does, it may be considerable in reference to Mens Health, to employ Fire which may be

least noxious.

COROLLARY IV.

From hence it likewise appears, that so subtle, spirituous, and sugitive a Body as Fire, may by uniting with congruous Parts of Matter, form a ponderous and stable Body; and whether the Sun-beams may have the like effect on several Bodies it works upon, I shall leave to be considered. And I shall also leave others to consider, whether all the Particles of Fire and Flame, that are subtle and agitated enough to penetrate Glass, and sasten themselves to included Bodies, be reduced by Ignition to the same Form, or else

else retain somewhat of their proper Qualities. only I shall add, that in such kind of Inquiries it may be of use to compare the specifick gravities of the Calces of Metals, made in Glaffes, by the operation of Flames, whose Fuels are of very different Natures.

CHAP. XVII.

New Experiments touching the relation betwist Flame and Air.

DEfore I lay down the Experiments, I shall first proceed to offer the Difficulties which occurr'd in the Tryals; and first, that some of them in which the Burning-Glass was employ'd, I could only try them in clear Sun-shining Days, the concentred Rays of the Sun being otherwise inconveniently reflected and partly refracted. Secondly, Where I was forced to employ hot Irons, if the Cavity of the Receiver was large, the Iron would be cold before the Air was exhausted; but if it was small, the Cement would be melted; fo that I was forced to make use of a peculiar fort of Cement, which was not fo fubiect to be melted.

But to these difficulties I shall add, that we must not be too apt to conclude, that the Receiver in these cases is exhausted sufficiently, when the Mercury in the Gage is depressed; fince that may happen upon the account of the Air expanded by the Heat of the Iron; and

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therefore the Air is to be exhausted, 'till the Mercury in the Gage can be depressed no lower.

But if it should be asked, whether a Vacuum may not more conveniently and speedily be made by Mercury, in the Torrecellian Experiment? I shall answer, That tho' the Vacuum be more nimbly made, yet the Phanomena exhibited there are apt to be influenc'd by fome extricated Particles of Air expanding themselves. it being impossible to leave that space wholly void of Air; besides it appears by a Bubble being broke in my Engin, that it exhaufts the Air more clearly than Mercury; fince in a Vacuum made by the latter, the Air included in a Bubble was never able to expand it felf powerfully enough to break it. Besides, there is one conveniency in our Engin, that, as Air extricates it felf, it may be drawn out by plying the Engin as occasion requires, whereas in the Torrecellian Experiment, the Vacuum is made all at once; belides the Mercurial Tube is not fo proper for the following Experiments as our Engin is. But to proceed to the Experiments contained under the following Titles.

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The I. TITLE.

Of the dificulty of producing Flame without Air.

EXPERIMENT 1.

An endea-Boyliano.

Piece of red hot Iron, half an Inch in Diameter, and an Inch thick, being con-Vacuo vey'd in a glazed melting-Pot into our Receiver, we carefully exhausted the Air, and letting down flowers of Sulphur in a Paper, the Paper was prefently confumed, and the Sulphur falling into the Concave Surface of the Iron. only smoaked a little, but did not actually kindle.

EXPERIMENT II.

Another way we made use of to kindle Sulphur in Vacuo was, by putting Flowers of Sulphur into a Glass-Bubble, and when the Air was exhaufted, placing it upon live Coals, the Heat would not kindle the Sulphur, but raise it in the form of a yellow Varnish up to the opposite side of the Glass, and by turning that to the Fire, it would rife again to that fide of the Glass which was uppermost.

EXPERIMENT III and IV.

To shew how much interest the Air hath in the production of Flame, when the Sulphur was too cool to burn without Air, we took off the Receiver. n-

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Receiver, upon which it presently slamed: And another time when the Receiver was thrice successively so far exhausted, that the Sulphur ceased to Flame, each time, that the Air was again let in, we could discern several slashes of fire, which by their blue colour appeared to be Sulphureous slames.

EXPERIMENT V and VI.

The Beams of the Sun in the Summer being Endervours cast upon Gun-Powder in Vacuo, it first smoaked and then melted, but did not explode whilst der in Vas
I continued the use of the burning Glass. But cuo.
another time having convey'd the Iron mentioned before red hot into our Receiver, as soon as it was exhausted we let down a piece of Paper with Gun-Powder in it, and tho' the Paper was consumed, and the Sulphur melted, yet it did not go off. But the Experiment being repeated with a grain of very good Sulphur, when it had burnt so long that we no longer expected an Explosion, I let in the Air, and sometime after it went off.

EXPERIMENT VII and VIII.

Several grains of Gun-Powder being convey'd into an exhausted bubble, and that placed upon the live Coals, it flamed considerably and afforded sublimate, which by the light of a candle exhibited livid colours of a Rain-Bow. In our *Physico-mechanical* Experiments, we mentioned an Experiment where a Pistol was fired in our Receiver; but the Receiver not being then

Experiment, and found, that when by the help of the Turn-Key, the Trigger of a primed Pistol was pulled by a string purposely fastned to the Trigger and Turn-Key, the Powder in the Pan would not go off, yet when a little Air was let in, the Gun-Powder remaining in the Pan, would stash off when the lock was cocked, and let off as before; yet one thing observable was, that tho' the Gun-Powder would not explode, when the Receiver was totally exhausted, yet the violent percussion of the sint would cause sparks of fire to sly from it.

EXPERIMENT IX.

Aurum Fulminans was exploded in the exhausted Receiver with a considerable noise, by the Sun-Beams cast upon it with a burning Glass; and a quarter of a grain being let down by the Turn-Key upon a piece of Iron red hot, it exploded with a stass, which was visible; the place where the Experiment was tryed being purposely dark; and a yellowish powder was scattered about the Cavity of the Receiver.

The II. TITLE.

Of the difficulty of preserving Flame without Air.

EXPERIMENT I.

Flowers of Sulphur being kindled upon a of the metalline Plate and convey'd into the Re-Raming of sulphur in ceiver, when the Air began to be fucked out Vacuo, gradually decay'd, till at the last, the Receiver being totally exhausted, the Flame was extinguished, and upon a reingress of Air, it only began to smooth again.

EXPERIMENT II.

A larger piece of Iron than that formerly mention'd, being made use of, and convey'd into a Receiver, a good quantity of Sulphur was let down upon it, which flamed considerably, and continued not only till the Receiver was exhausted, but a little after, and till it seemed

to be extinguished for want of fuel.

In trying of which Experiments, the following particulars are to be observed. First, that the Iron is placed on a Pedastal of Tobaccopipe-clay not too near the Glass lest it should break it. Secondly, upon the concave Surface of the Iron, we placed a Convex-shell which was shaped like a flattish bottom, to keep the Hane from having too large a Surface, and consequently from consuming too fast. Thirdly, it will be convenient, for the more commodious discern-

discerning of the Phænomena of this Experiment to try it in a dark place. And fourthly, it is convenient to advertise that the Sulphur frequently fo obscures the Glass with its fumes. which partly flick to it, that fometimes it is very difficult to differn what happens within the Glafs. Fiftinly, it is requisite the Heat of the Iron should be considerable, that the Flame of the Sulphur may be more lasting ? the flaming of it depending on the Heat of the Iron, and not the force of its own Flame.

EXPERIMENT III.

A very volatile and faline piercing Liquor being dropped upon filings of Steel, the Mixture grew hot, and emitted out of the Vial it was contained in, very fetid steams, which would kindle at the flame of a Candle, and continue to burn a good while; where we convey'd it into our Receiver, and upon the first Exsuction of Air it flamed brisker than before; and likewife upon the second and third; but after it, went out, it would not be kindled again, tho? the Air was let in upon it.

EXPERIMENT IV.

Spirit of Wine being impregnated with a Mineral, which tinged its Flame, I convey'd it into the Receiver in a small Glass-Lamp with a slender wick; and observed that in half a minute after the Pump was plyed, the Flame was extinguished: But letting Air in and out as occasion required, I observ'd, that when the Flame began to decay,

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the Turn-Key being successively drawn almost out, the Flame lasted a minute and a half, and fometimes longer. The Turn-Key being taken out in the beginning, it lasted two minutes or better. A Pipe being bedded in the Cement at the bottom of the Glass, and having at each end an open Orifice, almost of the bigness of that which the Turn-Key usually fills, the Flame burnt very well, and would have continned longer than it did if we would have permitted it. The Orifice at the top being stopped, the lower was left open, yet the Flame began to decay, but Air being blown in with a pair of Bellows, it was presently refreshed again, yet in a minute after it was quite extinguished.

EXPERIMENT V.

Tho' it is taught that Naptha and Camphire Hame prewill burn under Water, yet I could never find ferved imthat they would; but three ounces of Gun- der Water: Powder, a drachm of well burnt Charcoal, good Sulphur half a drachm, of choice Salt-Petre hear a drachm and a half, being all powdered and mixed together, a Quill or a Tobaccopipe stopped at one end being filled with this Mixture and kindled in the Air, would burn, till it was wholly confumed, under Water, the force of the Flame keeping the Water from breaking in upon it at the open end. In which Experiment Flame feems to be continued without Air, there being no Air to preserve it under Water, but what may be lodged in the Pores of the Water; except some moist Particles betwixt the Particles of the Nitre, in favour of the necessity of Air to preserve Flame, may be supposed to be rarified and form Air for a time, as the rarified exhalations which flow out of an . Lolipile, which are not true and permanent Air, but presently return to Water again.

EXPERIMENT VI.

Having placed the piece of Iron, fo often flaming, of made use of in our Receiver, we designed to let a parcel of Sulphur fall upon it, but when we went to drop the Sulphur down, by accident it fell on one fide the Iron; and whilft we were confidering what to do, we discerned a a blue Flame in the middle of the Glass, which continued much longer than that of ordinary Sulphur, and when we opened the Receiver, we found that it was afforded by a metalline fubstance which lay melted in the middle of the concave fuperficies of the Iron, being a compofition of Lead and Tin; but tho' these Metals mixed, so opened the Bodies of each other as to yield a Sulphureous fuel for Flame in Vacuo, yet in the open Air they would not.

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The III. TITLE.

of the difficult Propagation of actual Flame in Vacuo Boyliano.

EXPERIMENT L

Having kindled some Sulphur, which was of a peculiar fort, upon the Iron so often mentioned, I let down a piece of Spunk upon it, when the Receiver was exhausted; and by being contiguous to the slames it was turned into a substance as black and brittle as Tinder, and disposed to kindle when touched with fire.

EXPERIMENT II.

Another parcel of the same Sulphur being kindled in Facus Boylians, Camphire, the inthe open Air, disposed to draw the Flame of Sulphur, yet it was not kindled by hanging in the Flame of it. And a Match being partly dipped in Sulphur, and let down upon the hot Iron, burnt as far as the Sulphur raught, but no further.

EXPERIMENT III and IV.

Having placed a piece of Paper upon the Plate of our Pump and whelmed over it a very clear and thin Receiver, we laid a train of Gun-Powder upon the Paper, and observed, that the by a good Burning-Glass, several grains would be exploded; yet those would

not kindle those that were contiguous to them, the Propagation of Flame so much depends on the free access of Air. And to confirm this, I shall add, that a little Instrument made to try Gun-Powder, being charged and primed and suspended in Vacuo, tho' by the help of a Burniug-Glass the priming would be exploded, yet that would not kindle the Powder contain'd in the Box; but when the exhausted Air was let in again, and the Pan new primed, tho' the Receiver was shut, it would in that close Air go off readily; and also in the open Air.

EXPERIMENT V.

Gun-Powder being put into two Bubbles, one of which was exhausted and the other not, they were placed upon Live-coals, upon which, when they had stood a while, they where both burst in pieces, but without the appearance of any Flame, which effect seemed to depend on this, viz. That the Heat of the coals acted not only on a few grains of Powder at once, but upon the whole Area, so that every Particle being equally acted on, as to sense, they were exploded at the same time, so the Focus of a Burning-Glass acting uniformly on Aurum Fulminans, causes it to explode at once, but it may be so ordered, that the Focus not sufficiently warming one Part, a partial explosion will only ensue.

CHAP

CHAP. XVIII.

New Experiments about the relation betwixt Air and the Flamma Vitalis of Animals.

EXPERIMENT I.

D Ectified Spirit of Wine contained in a Glas- included in Lamp with a thin Wick, and at the same Receivers time, a small Green-Finch, being both convey- with Flame ed into a Receiver eighteen Inches high, and which was large enough to contain about twenty pints of Water, the Flame of the Lamp was extinguish'd at the end of two Minutes; but the Bird being brisk at the end of the third Minute. was taken out. And when the Bird recover'd again, the Experiment being repeated, the Flame was extinguish'd in two Minutes, but the Bird continu'd well longer. The Experiment being again repeated with two Lamps, they were both extinguish'd in a Minute, but the Bird continued well five or fix times as long.

A Mouse continued well a long time after the Lamp was extinguish'd. And the same Mouse being thut up in another Receiver with a Wax-Candle, seemed to have received no damage ten Minutes after the Candle was out, tho' the

Air was clouded with the Smoak of it.

EXPERIMENT II.

A Gold-Finch and a Piece of a Candle being included in a Receiver, large enough to hold two Galons, the Candle was extinguish'd in two Minutes; but the Bird in that smoaky Air continued well a good while after. like succeeded with a wax Taper in another Receiver. Being shut up with a piece of a Candle in another Receiver, which the Air was drawn out of, the Bird out-lived the Flame, but not without Convulsions. And the like fucceeded with a wax Taper.

The fame Bird being included with a piece of Charcoal two Inches long, and half an Inch thick, when the Air was fo far pumped out, that the Coal was past being renewed by letting in the Air, the Bird was fick, but prefently recover'd. And the same Experiment was repeated with the like fucces. Whether the Fire and Flamma vitalis of Animals feed upon diftinct parts of the Air or not, and whether the former destroys its Pabulum sooner or not,

EXPERIMENT III, IV, and V.

I shall leave to be consider'd.

Of the Bin-Worms.

It being the opinion of some, that the shining of Glow ing of Glow-worms proceeds from a kind of Efful fion of the Biolychnium, or Vital Flame; shall subjoin, That Glow-Worms being included in a Receiver in the Dark, as the Air was exhausted, their Light was diminish'd, and as it was let in again, renewed. And lest this should should depend on the Glow-Worm drawing the luminous Part of its Body into the dark Part, and so obscuring it, I enclosed the luminous Parts by themselves, and observed the same Phenomena as before; save that, upon the Reingress of Air, they seemed more lucid than before. The like Experiments being repeated with a dead Worm, it at the first retained its Light when the Air was exhausted, but after a while it diminished and increased as the Light of a live one, only it shone more vividly, and as the Light of the live one was a greenish blue, so this afforded a white yellow.

EXPERIMENT VI.

A Mouse being weighed alive, and then strangled, the nothing tell from him, he seemed it of a grain lighter when dead. And a young Catlin of about ten or eleven Ounces weight, lost four grains of its weight whilst a strangling, so many subtle parts being evaporated by its violent Struglings. So that the common Tradition that Animals are heavier when dead than alive holds not true. To this Experiment, I shall add, that having enclosed Silk-Worms Eggs, and those small Insects which turn to winged Insects, and form Gnats, in Vacuo, neither of them hatched or generated as in the open Air.

Q4 CHAP.

CHAP. XIX.

New Experiments about Explosions.

THE Learned Dr. Willis, and others having endeavour'd to account for some Phanomena by Explosions, I shall lay down the sollowing instances of Explosions made by Liquors.

EXPERIMENT I.

Strong Spirit of Nitre being put into a Bolthead, to the quantity of an Ounce, upon the Affusion of Spirit of Wine, part of it flew up to the Ceiling of the House, and dropping down upon a Man's Skin burnt him terribly; and as Spirit of Wine was successively poured in, it grew intenfely hot, and emitted red Fumes, which would take Fire at a Candle held a quarter of a Yard from the Mouth of the Glass, and would burn there 'till blown out, And an ounce of Spirit of Nitre being conveyed into another Bolt-head, and a Bladder tied over the top of it, which contained Alkobol of Wine, a little of it being poured into the Bolthead, it caused a vehement Explosion, by which the Bladder was presently expanded, and the Fumes presently made their way out in the form of an Orange-colour'd Smoak.

EXPERIMENT II and III.

Oyl of Vitriol and Oyl of Turpentine being fhaken together, produce a strong Ferment, and



and an Expansion or Explosion. The Blood of Fifes and Sea-Monsters is actually cold, and yet they move very violently; wherefore in favour of those that believe Animal Explosions, I shall add, that if Oyl of Vitriol and Sal-Armoniack be mixed gradually, the one being contained in a Bladder, and the other in a Bolt-head, to which it is tyed(as in the first Experiment) when the Sal-Armoniack falls upon the Oyl, it will canse a violent Explosion.

CHAP. XX.

New Experiments concerning the relation betwixt Light and Air, in shining-Wood, and Fisher. Communicated in the Transactions of Jan. 6. 1663.

EXPERIMENT L

Piece of good shining Rotten-wood, be- Oftherelaing conveyed into our Pneumatick En- tion begin, at the seventh Suction it began to grow and Air. more dim, and at the tenth it quite lost its Light.

EXPERIMENT IL

But as foon as the Air was let in again, the Light appeared again like a little Flash of Lightning, and more vivid than before. These Experiments being a second time tryed, the Light was diminish'd at the second Exsuction, and at the the fixth disappeared, which was but fix Minutes from the first Exsection.

EXPERIMENT III.

In a third Tryal, the Wood having been kept in Vacuo half an Hour, recover'd its Luminousness upon a re-admission of the Air.

EXPERIMENT IV.

A fining Body being included in a Receiver, and the Air exhausted 'till the Body had almost lost its Luminousness, we lest it some time in that rarify'd Air, and observed that the Light gradually diminish'd, tho' the Receiver was no further exhausted.

EXPERIMENT V.

Having included shining-Wood in such an Instrument as Mr. Hook hath invented to compress Air, I found, that the the Air was forcibly compressed, the Light was not sensibly impaired.

EXPERIMENT VI.

Shining-Wood being included in a fealed Glass, for two Days retained its genuine Luftre, but the third Day the Light was more obfeure.

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EXPERIMENT VII.

What effects the exhausted Receiver would have had on Bolonian Stone, Diamonds and Glow-Worms, I had not opportunities to try: But a piece of red hot. Iron being stuck in To-bacco-pipe-Clay, and convey'd into the Receiver, there was no sensible effect produced by evacuating or replenishing the Receiver.

EXPERIMENT VIII.

Wood being inclosed in a Glass hermetically fealed, and that convey'd into the Receiver, the Rays of Light were equally visible through the vacuous Medium, as through the Air when let in again.

EXPERIMENT IX.

We took a Glass Tube sealed at one end, and putting a piece of shining-Wood into it, we propped it with a Cork, to keep it from salling out; which being done, we inverted the open end of the Tube into stagnant Mercury, and conveying it into a Receiver, we exhausted the Air, that that in the Pipe by expanding it self, might make its way out, through the Quick-silver; which being done, we observed, that the Wood which lost its Light in the rarified Air, recover'd it again, when by the Presure of the external Air the Mercury was buoyed up within two Inches of the Wood, the rarify'd Air being thereby condensed again.

EXPE-

EXPERIMENT X.

A shining Fish which was very vivid, lost much of its Lustre, when the Air was drawn out; and a small piece of it, which was less luminous lost its Light in another Receiver, but recover'd it again, when the Air was let in again.

EXPERIMENT XI.

To try whether the Fish which retain'd its Light in some measure, did it upon the account of some peculiarity in its Nature, I enclosed a large piece of Wood in a Receiver, but it lost its Light in Vacuo, and regained it when the Air was let in again.

EXPERIMENT XII.

Rotten shining Fishes being included in Vacuo twenty four hours, they regained their Light again when the Air was let in.

EXPERIMENT XIII.

Confidering how much Putrifaction contributes to the shining of Fishes, and the Air to Putrifaction, I took a Fish, and hanging a piece in the Air a little before the time they usually grow luminous, I included another in Vacuo, to try whether the Fish would grow luminous there, or whether, tho' it appeared not to be so, yet when the Air was let in it would disclose its Light;

Light; but the Attempt being twice made, the one was frustrated by the breaking of the Glass; and the other, by the peculiar Qualities of a Fish, which in the Air grew not luminous in the usual time, nor much beyond it.

EXPERIMENT XIV.

A shining Fish being immersed in Water in a wide mouth'd Glass, was not at all affected, upon the exhausting of the Receiver, or when the Air was let in again.

EXPERIMENT XV.

A shining Fish, which lost not its Lustre upon the exhausting of the Receiver, was kept in
Vacuo forty eight Hours, in which time it lost
its Light wholly, 'till the Air was re-admitted,
and then it shone again; but the Receiver being
a second time exhausted, it lost its Light in four
Hours, but renew'd it again upon a re-access of
Air.

The suddenness of this renewed Light, put me in mind of those Lights which are sometimes seen in Vaults and Caves newly open'd, and upon the first ingress of Air; but those are not so lasting, by reason of the less tenacity of the substance which yields those luminous Rays.

Another Fish being included in Vacuo three days, renewed its Light when the Air was let in; but a third did not recover its luminous quality 'till it had remained sometime in the Air. And two other shining Fishes, being included three Days in Vacuo, when the Air was

let

Book IV

let in again, that which was first most vivid. recover'd its Light first; and the other some time after.

CHAP. XXI.

Observations and Tryals about the resemblances and Differences between a burning Coal and Spining Wood. Communicated in the Transactions of Feb. 166%.

Resemblances.

ces of a fbind Wood.

Resemblan- 1. DOTH of them afford Light. 2. Both of D them require the presence of the Air to continue their Light. 3. Being deprived of Light by withdrawing the Air, they recover it again' upon the re-access of it.4. Both of them will lest their Light in Water. 4. Coldness of the Air extinguishes not their Light; for, shining Wood being put into a Glass Tube sealed at one end, and that placed in a frigorifick Mixture, 'till Water contained in another Pipe was froze, it ftill continued Light, tho' a fhining Fish loft its Light in a quarter of an hour.

Differences.

Their Differinces.

1. A live Coal would be extinguish'd by Compression, but shining Wood will not.

2. Shining Wood will recover its Light when the Air is let in again, but a Coal will not.

3. Shining

3. Shining wood will contine to give light in a close Glass, but the Coal will not.

4 A Coal emits fmoak, but the other does

not.

5. A Coal confumes, but the other does not.

6. A Coal is hot, but shining wood is not warm, which I discovered by applying to the shining wood the Ball of a Weather-Glass described in the History of Cold, in whose Stem is contained a Pendulous drop.

CHAP. XXII.

Some Observations about shining Flesh, communicated in the Transactions of December 16. 1672.

A Neck of Veal which was observed one A Flesh Night to be Luminous in the Larder, which shines afforded the following Phænomena in a dark Room.

1. It shone in several places; those shining spots varying likewise in bigness and form.

2. The Parts which shone most were those grilly or bony places which the Butcher's cleaver had past. And we perceived likewise that the Medulla Spinalis did shine. One place of a Tendon shone, and several spots in the slesh distant from the Bone.

3. By the light afforded by these spots, I could discern several Letters in the Title of the Philosophical Transactions; the most vivid Rays being of a greenish blue, like the tails of Glow-

worms.

worms. Neither a Weather-Glass or the touch could discover any more Heat in those Parts than in others; nor were they in the least putrid.

4. The window of the Larder is Northward; and the floor a ftory below the Kitchen, and feparated from it only by a Boarded floor.

5. The Wind was high, and South-west, the Air being hot for the season. The Moon was past its last quarter, and the Mercury in the Barometer stood at 29 is Inches.

6. A piece of a shinning bone being cut off the thickness of half a Crown shone on both sides, and the place it was cut off shone likewise

but more faintly.

7. The Flesh lost some of its light by rubbing; but imparted no light to my hand: But the Flesh being pressed betwirt two pieces of Flesh

it loft nothing of it's Light.

8. A piece of it, having lain a quarter of an hour in inflamable Spirit of Wine lost its Luminousness; but in Water it continued an hour without being impaired. But being convey'd into our Pneumatick Engin, it was diminished gradually and considerably.

9. I observ'd several Luminous places in a Leg of Veal brought out of the same Lar-

der.

10. A piece of Veal kept all Night in a Phial, fhone in the Morning, and continued its Light till the fixth Day at Night.

11. A Pullet hung up in the same Larder,

appeared also to be Luminous.

GHAP

C H A'P. XXIII.

Observations of a Diamond that shines in the dark.

HAving met with a Diamond, which, the objervatt-it would not yield light in the day, on on Diwould afford a conspicuous light in the Night, amonds. I thought it would be of no small use in explaining the abstruce Nature of Light. And tho' a great many think it no rarity, that there are Carbuncles and Diamonds which shine in the dark, yet there are some who deny, that there are any shining stones at all, as Boetius de Boot; Johannes de Laet, and Olaus Wormius, yet Vatemamus and Garcias ab Horto, pretend to be Eye witnesses of Carbuncles which shone in the dark; and Marcus Paulus Venetus tells us, that the King of Zeilan had a Rubie as thick as a Man's arm, and a Palm long. And two Russian Cossacks tell us, that they heard from the People of Cottay, that their King had a Rubie which would shine Night and Day. And Benvonuto Cellini, an Italian Writer, gives us an account of a Carbuncle which afforded a considerable Light in the Night. And we our felves have been informed of a fhining substance found in Scotland.

And I am further told, that a Dutch Admiral had a Diamond, which when he opened a Coffer under Deck in a dark Room, would shine by its native Light, which is the more strange, because that is a much colder Climate than the East-Indies; for it is observable, that warmth

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much contributes to the shining of such stones, fince rubbing will cause some to shine, which when cold will not; which makes me the less doubt of what is faid of right Turquois, viz. That it changes colour as the wearer is fick or well, and lofes its splendor after Death, which is attested by the Observations of Boetius de Boa. and Olaus Wormius; and tho' Antonio Neritch us, that a Turquois discoloured and grown white, will regain its colour, if immerfed in Oyl of fweet Almonds, yet Wormins tells us. that a Nephritick stone being dipped in a Decoction of herbs lost its virtue. And it is obferved, that the Texture of Oculus Mundi will be fo changed by being left in Water, that from Opacous it will become Transparent, which acquired luftre it will foon lose in the Air.

Observations made on Mr. Clayton's Diamond.

It was a flat Table Diamond 3 of an Inch long, and less in breadth, of a bad Water, and less vivid in the day than other Diamonds, being blemished with a whitish Cloud about the middle of it, which blemish covered near a third part of the stone.

This Diamond being looked upon in a shady place in the day, and also with a Microscope, neither any thing peculiar in the stone, nor a-

ny light was perceived.

Secondly, when the Candle was removed in a dark Room, it did not shine without being rubbed or otherwise prepared.

Thirdly,

Thirdly, I could neither produce Light by rubbing together two Pebbles, nor by a vehement attrition of Rock-Crystal, nor by two Diamonds, as by this stone.

Fourthly, it was hard enough to grave upon Rock-Chrystal with it, and was endewed with

an Electricity.

Fifthly, by rubbing it in the dark, it would be excited to shine like rotten wood, but much sainter than the scales or slabber of a Whiting, or than Glow-worms; and it presently ceased after the attrition was ended. But being rubbed brisksly it would continue its Light much longer, so that it lasted eight times as long as it was a rubbing.

Sixthly, holding it near a faint fire excited its Luciferous Qualities a little, but by holding it near a Candle it was more apparently excited in a dark Room; and it acquired a little glimmering by being field near a red piece of Iron, as also by being contiguous to my naked Body

fometime.

Seventhly, by being rubbed till it acquired Luciferous Qualities, it was also Electrical, but not when it was excited to shine by the Heat of

the Fire or a Candle.

Eighthly; attrition varied its Luciferous Qualities, as the Cloath varied in colour; but on white and red it succeeded best. It was likewise excited in some measure by being rubbed upon a white wooden Box; and a purely glazed Earth, which excited it much better than any other Body except white ones.

Ninthly, when it was excited, being plunged into Water, Spirit of Wine, Oyls of all forts,



Acid

Acid Spirits, and Alkalizate Solutions, none of them destroyed its shining properties, but when it was taken out of the Water it was not so easily excited as before.

Tenthly, neither Spittle nor warm Liquon would extinguish its Light; but being rubbed with a transparent horn, I could discover Light through it, and sometimes little sparks of fire

Eleventhly, being rubbed upon a blue Glass, the faint Light was not visible through it, but being first excited and then applyed to the Glass, the Rays were tinged in their passage

through it.

Twelfthly, by pressing it hard upon a piece of white Tyle it became Luminous, as also it discovered a short Coruscation when I pressed my finger upon it. And if I thrust or stuck the point of a Bodkin against it, it would discover a short, but not a lasting Coruscation, so that it Light seemed to be promoted by pressure rether than attrition.

The same Experiments being tryed with other precious Stones, some Diamonds would by attrition be brought to a glimmering Light, but others would not; but neither the other precious Stones, nor Artificial or Natural Chrystal would afford the least glimmering of

Light.

CHAP. XXIV.

The Aerial Noctiluca, or some new Phanomena; and a process of a Factitious self-shining Substance.

Hosphorus's are either natural, as Glowworms, fome forts of rotten Wood and Arrial No-Fifes; or artificial, which are the chief subject of this discourse; and are either, First, such as will retain a Lucidness sometime after they have been exposed to the Sun-Beams, as the Bolonian Stone, and Phosphorus Hermeticus of Balduinus, which may be made of Chalk, the latter of which fucceeds much better than the former; for it is presently excited in the Sun-Beams, and even at the flame of a Candle, and coutimes to shine a considerable time in the dark; yet this advantage the Bolonian Stone hath above the other, that it retains its Virtue of being excited much longer. Or, Secondly, felf-shining fubstances, such as are usually called Nottiluca; and are either consistent or liquid, such & Mr. Craffe brought to London, the confiftent one being of a gummy Nature and constantly lacid; but the other apt to vanish, if exposed to the open Air. To which I shall add, one of my own preparation, which does not shine it felf, but when exposed to the Air, the Effluvia mixing with it became lucid, which therefore I call the Acrial Notiluca: In preparing of which, from fome Parts of a Man's Body, it was not only difficult to hit upon the true degree of Heat, but the Vessels in which it

was raised by Distillation, being not able to hold out so long as they should, we were forced to save the Luciferous matter, by small parcels and in distinct Vials.

Observations made on the Liquor which was contain'd in the second Vial, which the it was large enough to contain two ounces, had but a spoonful of the Liquor in it.

1. By Day-light this shining Liquor was not near Diaphanous, but of a muddy grayish colour. And when it was disposed to shine in the dark, the Cavity of the Vial above the Liquor seemed to be full of whitish sumes, tho'at

other times transparent.

2. The Vial when close stopped was not Laminous in the dark, but the Light or Flame appeared as foon as it was exposed to the Air, and the Vial was unstopped; and that the Accension and Propagation of this Flame depended on the contact of the Air, appeared, fince agitation would not kindle it, but when the Bottle was unstopped the kindled Flame would gradually be propagated downwards; and if a few Bubbles of Air were only let in by removing the cork aside and putting it close in again, the Flame would appear upon the top of the fumes, without being able to propagate it self much downwards. To which Observations I shall add, that when the Flame appeared it was most vivid the nearer the Air, and when it was extinguished, it first disappeared in the bottom, and then expired at the top. But when the Vial had been unftopped for fome fome time, when it was stopped again, the Air that had leifurely infinuated it felf would cherish the Flame for an hour or two.

3. It was observable, that when the Air had been long pen'd up with this shining Liquor. the fpring of it would be fo far weakned, that when the Vial was unstopped, the external Air would prefently rush in again, from whence appears the Interest of the Air, in promoting

the shining of this Acry Nocilluca.

As for the Reason why the Air should contribute to fuch Phænomena, I shall offer the Nociluca's following Conjectures, viz. That the Saline Parts of the Air, caused a Fermentation in the fames of the Liquor, by which means, they being briskly agitated, are either convey'd to. or unite with the common Ather, and affect the Eye joyntly; and tho' Mr. Craft's confiftent Notifica shines when closed up from the Air, yet that may be attributed partly to the Viscousness of the Luciferous matter, which is less apt to be diffipated; which I am the apter to believe, fince it being once exposed to the open Air, it was confiderably walted and was rendered much more violent; to that it produced confiderable effects of actual Heat. But tho' I am inclined to believe that the Air contributes thus to the shining of these Nottiluca's, by putting the Particles of the fumes into a brisk agitation, yet whether it acts immediately on the fumid matter it invades, or whether it diffipates it, or acts after the manner of a Vital Spirit, or further, whether the Air uniting with these fumes forms a Body fit to be agitated a-

bous

bout by the Ether, I shall leave to be further inquired into. But to return to our Observa-

tions.

4. Tho' agitation before the Vial was unftop ped would not kindle the Light; yet when it was opened, it would be increased by it. And even when it was in its dark state, if I poured a little of it upon my hand, and rubbed it with my finger, it would prefently become vivid. and emit store of Luminous Rays, as well as fumes very offensive to the Nostrils; and when I ceased to rub, and the Luminous Quality was loft, it would be renewed again by a repeated attrition; but in a little time its lucid Virtue would decay.

4. As for the degree of the Light of this Luminous matter, it was equal with that of fome rotten wood; and it was observable, that the Rays of it were reflected but weakly by black Bodies, but appeared very lucid when inclosed in white ones, tho' I could not perceive the Rays of it reflected from a redish Diamond or an Emerauld. This Light in respect of it self was Opacons, but transparent when held near external Light, and interposed betwixt it and

the Eye.

6. I tryed whether the Sun-Beams would excite those fumes, which are Concomitants of its Luminousness, but could not perceive them rais'd in the least. As for the Nature of this Liquor I could not perceive it upon my Tongue either Acid or Alkalizate, but Empyreumatical, almost like that of Spirit of crude Tartar, its finell being like that of an Empyreumatical Oyl, compounded with a stink like that of ftale stale Urine. It turned not Syrup of Violets green, as volatil Alkalies, or urinous Salts do; nor did it by other Tryals appear to be an Acid.

7. This Liquor in its lucid State being agitated, several consistent Particles being by that Agitation raised, and sticking to the sides of the Glass, appeared to be more lucid than the Fumes. Having wet my Finger with this Liquor, and rubbed it upon my Hand 'till it became luminous, I immersed my Finger in Water, upon which the Light was extinguished; but when I took it out of the Water, and rubbed it again, it became lucid as before.

8. But twice I observ'd, that there was such a peculiar Temper in the Air, that it continu'd to flame twelve or fifteen Hours after it had been stopped up. And at last this Liquor became so effecte, that it would not yield Light, 'till its Parts were agitated by Attrition, or put

into motion by the Heat of the Fire.

9. To what Observations have been already made, I shall add the following, made on the Liquor contain'd in the first Vial:

Observations on the Liquor contained in the first Vial.

1. The Liquor being muddy shone ten hours after it was first poured into the Vial, and when the Vial was unstopped the Fumes were put into a circular Motion round the sides of the Glass, like a Whirl-wind; which perhaps might depend in some measure on the violent Ingress of Air, upon opening the Vial; the I have some-

sometimes observ'd lucid Rotations of Matter in the Cavity of the Vial, a considerable time

after such Eruptions.

2. The Flames which were afforded by rubbing these Liquors, yielded white Fumes of a rank offensive Smell; the Colour of the Flame being yellow, and tremulous in their Motion, and inconstant, sometimes flashing out more than at other times; but it neither burnt the Skin, nor finged fine Linnen: So that if any, it must resemble that Flamma Vitalis which is supposed to reside in Animals.

3. A Pencil being dipped in this Liquor, and drawn upon white Paper, deposed only its watry part; but the more gummy Matter in the Pencil being squeezed out, it seemed to burn like a Candle, and sometimes shooting downwards, as if it were played about the Hairs that made up that part of the Pencil, which brought

into my Mind those Verses of Virgil,

Ecce levis summo de virtice visus Iuli Fundere lumen Apex, tacque innoxia molli Lambere flamma Comas, &c. Æneid.

And it was observable, that this Flame would fuccessively appear and disappear for a considerable time, and fometimes when the wreathing of the Hairs was violent, the Flame would be accompany'd with a momentary, tho' fensible Heat, yet it would not fire Gun-powder; the' fome of the confiftent Matter, whilft it was preparing, being taken out with a Knife, and the Knife rubbed betwixt the Thumb and Fingers with a blue Calico Apron, the Matter received

ceived such an Impression from that Attrition, as put its parts into so violent a Motion, that two Holes were burnt in the Apron. Some of the Liquor contained in the Receiver, and diluted with Water, turned Syrup of Violets

green, and fermented with Acids.

4. Some of this Liquor being contained in a Vial, and convey'd into our Pneumatick Engin, tho' the Air could not be so far exhausted, but that there was a fufficient quantity left behind to kindle the Flame; yet the Commotion occafion'd by Pumping, would be, as if it were ventilated, or blown up, and made to shine more vividly. And a piece of Paper moisten'd with this Liquor, being convey'd into a Receiver, tho' by the Commotion of the Receiver, the Flame seemed to be still increased, yet in those Parts betwixt the Folds it appeared to be much less than in the open Air; and tho' when moist Air was let in again the Flame was extinguish'd, yet upon a removal of the Receiver, when the Paper was exposed to the open Air it renewed its Flame.

5. Some of this Liquor being at the first filtred, the Substance remaining in the Filtre being enclosed with it in a wide-mouthed Glass, it became luminous when exposed to the Air. And another piece of Paper being shut up in another Glass, when it was spread open in a dark Place, several Flashes sprang out incessantly and successively, first in one place then in another, and were not only various in their Figures, but had frequent Emications and Tremblings.

6. Some of this luciferous Matter being diffolv'd in an aqueous Liquor, which was tran-

fparent

fparent when it was setled, tho' a moderate Agitation would not produce Light in it, yet be
ing set in a Sand-heat in a Bolt-head 'till the
Ball was too hot to be touched with ones band,
I caused it to be removed into a dark place, and
found that it had acquir'd a manifest Luminousness, and the Liquor being variously agitated and broke, several Flakes of Light ascended
to the top of the Stem; and when the Liquor
was agitated 'till it was spread over the inside
of the Ball and part of the Stem, it was adorned with luciferous parts of Matter, which
twinkled like so many Stars, and descended in
Lines, some of which were very oblique and
pleasant.

7. Once I observ'd, that when the Liquor contain'd in a Bolt-Glass was not very hot, having given it a rude shake, a Spark rose on one side, and spread all over the Cavity of the Ball. And to what hath been observ'd, I shall add, that some of this Liquor having been hermetically sealed up, it retain'd its succiferous Quali-

ties a long time.

8. The way to make the Phosphorus Balduini, is the following, viz. Having dissolved fine white Chalk in Spirit of Nitre, or clean Aqua fortis, it must be filtred through Cappaper, and the clear Solution is to be evaporated till there remains a dry substance; which being spread over the inside of a round Vessel which will endure the Fire, you are to give it a peculiar degree of Heat; and which commonly requires a convenient shaped Vessel, whereby the Flame or Heat may be reverberated, 'till the Matter hath acquired a disposition to retain Light;

Light; and then the Vessel must be covered with a Glass or fine Crystal Cover, to keep it

from the outward Air.

10. The Process which we took to make our Aery Notiluca was the following; We took a confiderable quantity of putrified Urine; which was distill'd 'till all the spirituous Parts were drawn off; after which the superfluous moisture was also abstracted, 'till the remaining Subfrance was brought to the Consistence of a thick Syrup, which being well incorporated, with three times its Weight of white Sand, the Mixture was put into a strong Retort, to which a large Receiver was joined in a good measure filled with Water: Then the two Vessels being carefully luted together, and a naked Fire being gradually administred for five or fix Hours. that the Phlegmatick or Volatil Parts might come over first. When this was done, the Fire was increased, and at the length for five or fix Hours, made as ftrong and intense as the Furnace was capable of giving; by which means good store of white Fumes came over, almost like those that appear in the Distillation of Oyl of Vitriol, which when they are past, and the Receiver grew clear, they were after a while fucceeded by another fort, which feemed, in the Receiver, to give a faint blueish Light, almost like that of little burning Matches, dipt in Sulphur. And last of all, the Fire being very vehement, a more ponderous Substance pasfed over, which fell to the bottom of the Water, which being taken out, appeared to be luciferous. But whether the shining Faculty depends on the volatil and spirituous Parts of this Animal Animal Liquor, or of the fixed Salt, and ponderous fætid Oyl, I shall not determine, 'all further satisfy'd by Observations.

An Appendix to the Aerial Noctiluca.

1. Some luciferous Matter, that had a long time lost its shining Faculty, being heated by the Fire, presently shone vividly enough, and continu'd to do so whilst it was sufficiently warm; but in a few Weeks, it likewise lost this Disposition of Heating. And tho' some consistent Matter had lost its Power of shining, yet the Superficies being taken off, the Matter that lay under it rubbed upon my Hand would presently become luminous.

2. Tho' this luminous Matter be not feculent, yet it usually leaves some of its gummy Parts sticking to the sides of the Vial, which may be discover'd by heating the Vial, or if it be broke in pieces, and agitated in another Vessel; for by that means, the Parts being rubbed one against another, and variously placed with their sides upwards and downwards, they

would every way diffuse a clear Light.

3. A twelfth part of a Vial being filled with a liquid *Phosphorus* of another kind, so that a greater quantity of Air might be contained in it, it continu'd to shine without unstopping the Vial. And I sometimes observ'd several Exhalations like Clouds, or Aggregates of Smoak, to roll to and fro in the Cavity of the Vessel; and would grow much more lucid upon shaking the Vial.

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4. When it had lost its Light for some time, it filled the Cavity of the Vial, when unstopped, with Fumes, which like those of the other Nociliuca's, appeared white in the Light, and luminous in the Dark. A Bolt-head half full of this luminous Matter being sealed up hermetically, it continued luminous six Days and Nights; and when a great part of the Liquor was poured off, the remaining Sediment being spread about the sides of the Glass, by inverting it, they appeared like so many bright twinkling Stars in a clear Night.

CHAP. XXV.

New Phenomena exhibited by an Icy Noctiluca, or a solid self-shining Substance; and first, some Qualities of the Noctiluca it self.

Having by a method, not unlike that taken to produce the Acrial Noctiluca, oblities of the
tain'd a confistent shining Substance, I observ'd
the following Qualities in it; and, first, It came
over in Distillation in little Grains of different
Shapes and Sizes, and most commonly irregular, being void of Colour, and when held against the Light, transparent; and the greater
Pieces looked so like Ice, that for that reason I
called it the Icy Noctiluca. But the generally
it was colourless and transparent, yet some
small Pieces were Opake, and of various Colours compared with each other.

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2. This Notifica is heavier in Specie than Water; and the confiftent, yet not so hard a common Ice; but it is brittle, and may be spread upon a solid Body, like the unmelted Tallow of a Candle, it may be melted in hot Liquors without waste, but in the Air a great Part of it will be consumed. As to sense it is Cold; but is of such a Texture that it easily becomes hot upon agitation.

3. When held in the Air it yields a vivid Light if wet over, and when first exposed to the Air, it not only shines, but emits store of Effluvia, as long as it is kept there; when it is immersed in Water it ceases to shine and also to smooth, but as soon as it is taken out, it begins a fresh, and if part be immersed and part above Water, the latter will shine vividly

the' the other will not.

The Qualities of Water in which is had been immersed.

. The Water in which this Notifuca had been fometime immersed, had a strong and penetrant tafte like a Mixture of Brine and Spirit of Salt, and relished a little of Vitriol. Being held in a small Concave Vessel of Silver over lighted Coals and ashes, it evaporated very flowly, and would not shoot into Crystals, nor afford a dry Salt; but coagulated into a fubstance like a Gelly, or the whites of Eggs, which would be easily melted by Heat. When kept on a hot fire it would first boil, and then make a crackling Noise, and the Explosions would be accompanyed with flashes of fire and light, which if they were small were generally blue, like flames of Sulphur, but more vivid, and sometimes bluer; but the greater flakes appeared yellow and very Luminous, and

these Phenomena appeared likewise for lime time after the Veffel was taken off. When matter was almost melted by Heat, if it was permitted to cook it acquir'd a rolinous Confiftence, and tinged the Flame of a Candle be . By the Fire working upon it, it acquir'd Garlick Smell, and being left in the Air all Nicht, it esrued to a Liquor almost as frong Spirit of Salt. Being par upon the Fire again, it would afford the same Phenomena as before, hat feme of the Matter which before broke opt in flakes, formetimes role only in the form of Smoak, of a rank Smell. And tho' the quantity of this Matter was finall, yet it afforded Flathes plentifully for an Hour.

It would not diffolye in cold Water, tho' What Lie the Water would be thereby impregnated; so query it Crecus Metallorum impregnates Wine or Wa- differed ter, without having its Bulk diminished It in, and fermented not with Spirit of Sal-Armon, nor did it lofe its luminous Virtue, but would shine when exposed to the Air again. Oyl of Vitriol when cold would not diffolve it, but when hot would melt it; and it would lye at the bottom of to heavy a Liquor, Aqu. fortis had no visible feet on it, nor Oyl of Turpentine when cold; but the latter being hot, it wholly vanish'd in Night's time, without making any alteration in the Oyle Being put into Oyl of Cloves, and melted by a Fire, when it was cool, and the Vial anstopped, it yielded not only a Light, that was render'd more acceptable to the Standets-by, by its grateful Smell; and the like facceeded with Oyl of Cloves, in which Liquor, when impregnated with the Noctiluca, it was obser-

observable, that the Vial being open'd in a dart place, it would yield a flash of Flame very vivid, which would last a Minute; and fome. times, if a Candle were in the Room, the fin ing fluid would appear of a pleasant blueish Co lour a and another thing observable was, the the Light would vanish, whilst store of white Pumes remain'd upon the Liquor, as if the Light chiefly depended on the finest and purest Part In Oyl of Mace it did not appear luminous nor in Ovl of Anifeeds. This Nottiluca continued in Spirit of Wine, a confiderable time undiminifhed.

6. This Notifuca being included in rediff Spirit of Wine, was partly dissolved; and left some earthy Parts at the bottom of the Ligar, but did not discolour it : upon unstopping the Vial no Light appeared, but being dropped into cold Water the Drops were kindled by it; but those Flashes immediately disappeared, the Water not being luminous; which Phanomenon, left it should be thought to be an effect of & tiperistasis, I dropped the impregnated Spirit upon hot Water, and found, that the same Phenomenon succeeded. And this Notifuca diffefes its Virtue fo far, that one Grain impregated a thousand of Spirit of Wine. As for the reason why these Flashes so suddenly disappeared, it might proceed from a sudden dispersion of the Particles of the Spirit through the Water, and the Avolition of the Inciferous Matter. So Camphire dissolved in Spirit of Wine, and drop ped upon cold Water, is left upon the Surface of it, the Spirit being immediately dispersed through the Liquor.

Expe-

Experiments discovering a strange subtlety of Parts in the Glacial Noctiluca.

Having dissolved a Grain of our Notifuca in Drachm of Spirit of Wine, and added gradually fifty times its weight of Water, the Notifica rendred the whole light, when shahen in the Dark, fo that one Grain rendred 100000 times its weight of Liquor luminous; and what was more strange, was, that not only the Steams appeared luminous, but the Light feemed in some measure diffused through the whole Water, which I am apt to believe proceeded from the Exhalations which shined through that Diaphanous Water, tho' when the Glass was shaken the whole Mass appeared lu-And the Experiment being further profecuted, a Grain of the Notifica dissolved in Alkohol of Wine, and shaken in Water, it render'd 400000 times its weight luminous throughout. And at another Tryal I found, that it impregnated 500000 times its weight; which was more than one part of Cochineel could communicate its Colour to, the utmost being 125000 parts of Water. In which Experiments, 1 of the Notiluca was undisfolv'd. And had we to the aforemention'd Estimate, added the Proportion of the illuminated ambient Air, the Expansion of this Nottiluca would have been incomparably greater than the abovemention'd number denotes.

But to demonstrate further the strange Subtilty of our Nocillucal Matter, I shall add, that three Grains of our Nocilluca being placed upon a flat-bottom'd Glass, that was broader at the Top than the bottom, and fhallow, that the Matter might be more fully exposed to the Air, it was placed in a shelving Posture, that upon its refolution in the moift Alr, it might presently run down, and not hinder the free Evaporation of the remaining Matter: The Vessel being thus placed, all the Fragments about ten a Clock at Night began to shine briskly, and continu'd to do fo 'till reduced to very small Parts; fo that so small a parcel of our Notifica continued to fhine above a hundred and fifty Hours. In which time the following Circumstances were observable, First, That the luciferous Fumes were visible both Night and Day; and rose from the Particles of the No-Giluca, like Smoak from so many Chimneys. Secondly, This Smoak was so copious and tenacious, that it lost not that Form 'till it rose a Foot above the Matter that afforded it; the Motion of it being fwift, and sometimes tending directly upwards, fometimes horizontally, and fometimes downwards, as if their Motion had been determin'd by the scitnation of the Noctifucal Fragments, by which they were emitted. And one thing further observable was, that when it had been a long time exposed to the Air it emitted ftrong and odorous Exhalations, diffinct from the visible Fumes.

As for the Liquor which dropped from this Notifica, and which remained in the Glass Vessel, I put it into a Concave Silver Vessel, and held it over Small-Coals and Ashes, where it evaporated not so easily as I expected, but turned into an unctuous Substance, of a dark red-

diff



dif Colour; and being thence removed and held over quick Goals, it boiled and crackled like Bay-Salt cast into the Fire, and emitted feveral faccessive Flashes. Another piece of this Notifica, which weighed three Grains, being put into a small Glass Funnel, whose Stem was to fine that it was less than a small Pin's head. and the Pipe of the Funnel being purposely placed in a Vial, to catch the colliquated Liquor; and this being fet in a South-Window all Day. and placed in my Chamber at Night, I observed, that it continued luminous no less than 360 Hours. From whence appear'd the extraordinary Minutenels of the parts of our Notiluce; and what is more strange, the Weight of or Noctilucous Matter colliquated, exceeded the Weight of the Notifica it felf two thirds,

This Notifice being spread upon Paper, and held to the Flame of a Candle, when the Flame came to the Notifuca, it burnt away in a flahing and spluttering manner, and cracked like Salt. And some of this Paper being put upon Embers cover'd with Ashes, the Not iluca would take Fire, and communicate its Flame to the Paper. And to shew its inflamability further, I put a Grain of it into Spirit of Wine, and tho' it discolour'd not the Flame of the Spirit, which was partly red and partly blue, yet when the Spirit was confumed, and the Flame was contiguous to the immersed Phospharus, it took Fire, and emitted a yellow Flame copiously. And a piece of this being fet on fire by the Sun-beams concentrated, it burnt very vividly and clear; and the expiring Flame left behind it a Caput Mortsum, which formed feveral Circles like

those of a Sardonix, whereof the largest was white, another yellow, and the third red, all the three Colours being vivid and pleafant. Some part of the Caput Mortuum being left in the Spoon, was presently refolv'd per deliquium. into a Liquor as sharp as Spirit of Salt; and other parts having free access to the Air appeared combustible.

Another instance of the Inflammability of it. was by rubbing it in a Mortar, for by that means it took Fire, and burnt vividly, but was

foon extinguish'd by the Fire.

If our Nociluca be pressed hard betwixt ones ming of Fingers, or against a Board, it will feel sensibly the Nocti- hot; and will fometimes be violent enough to fcorch the Skin: And one thing observable that Blisters raised by its Heat, are not only more painful, but harder to be cured than ordinary ones. But the' some parts of this No-Hiluca are disposed to take Flame, yet they are not all equally prone to an Incalescence. To these Observations of our Notifica I shall add, that some of it being rubbed betwixt Folds of Paper for fome time, they took Fire, and fo did it when rubbed with Gun-powder, by which means the Gunpowder was exploded: And once when my Servant carried fome of it in his Pocket, the Glass being broke, the Attrition and Heat of his Body fet it on Fire, by which means feveral Holes were burnt in his Breeches. To which I shall subjoin, that six Parts of Sulphur, and one of this being mixed and beaten with the haft of a Knife, the Notiluca shone through the Paper, and as soon as these Ingredients were exposed to the Flame, they imme-



immediately took Fire; and once the Experiment being repeated, the Brimstone did not burn with a slow Flame, but slashed away like Gun-powder. And once my Laborant having prepared some of it, and trying to write upon a dry Board, the force of Attrition kindled the Wood, and afforded not only vividly shining,

but burning Letters!

To try what was the Nature of this faline Nocillucal Matter, I dropped some of it upon syrup of Violets, and found that it did not turn it green, but of a fine Carnation Colour, as Acid Spirits usually do. And I likewise found, that it presently destroy'd the blue Colour, the not the other of the Lignum Nephritieum. I likewise poured some of this Noctilucous Liquor upon Filings of Copper, and expofed them to the Air for two or three Days, I found, that the' the Filings were diffolv'd, yet the Colour of the Tincture was not a deep Azure, as if made with a Volatil Uripons Salt, but feemed to partake of green and blue. It likewife fermented with Powder of red Coral. and also with Salt of Tartar. From whence it appears, that the nature of our Salt is not Urinous, but of the Family of Acids. But to proceed, I enclosed a parcel of this Icy Noctiluca in a small Vial, and another, together with the Water it came over with in Distillation, and I observ'd, that the former lost its Light in four Days, and the other in about a Week. But to try whether a sufficient Degree of Heat would not cause our Nocilluca to take Fire, I enclosed fome of it in a Glass-Egg, with Hermes his Seal, and found, that the Ball of the Egg being held

4 near

near the Fire, the Notifica prefently took Flame and burnt much longer than we expected; and when the Flame was over, we fometimes obferv'd a little Liquor in the Glass, the rest of the Matter, by the Operation of the Fire, ac-

quiring a red Colour.

Some of this Notifuca being put into a Glass Egg, and Water poured upon it, when the Water was heated very hot, and the Notifica was melted, we poured the Water off; upon which the Notifuca remaining in the Glass, immediately being exposed to the Air, took Flame, and part of it running out with the Water, burnt hereely upon the Surface of it, and with a crackling Noise, the remaining Caput Mortuum appearing red. To which relations I shall add, that the Beams of this Notifiuca, passing through an Orange colour'd Glass, appear'd of a very pleasant Colour. And on this occasion I shall subjoin, that the' once I could not obtain any Light from some of this Notiluca included in a Vial with Oyl of Mace, as with Oyl of Cinamon, yet upon further Tryals,I found that it incceeded. And to what hath been deliver'd on this Subject, I shall further add, when the Notifica was wholly confum'd to a Caput Mortuum, that as foon as it was turned with the other fide upwards, it would immediately take Fire a-fresh.

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ROBERT BOTLE, Efq;

EPITOMIZED.

BOOK V. PART I.

CHAP. I.

New Experiments of the Positive or Relative Levity of Bodies under Water.

HEN any Body that is lighter in Specie than Water is immerfed in against the it, and upon the removal of that Positive Laforce which depressed it, it rises again, it is usually attributed to the Positive Le- Bedier. vity of that Body; but fince the instance of Wood emerging is that which is usually offered as an Argument, to it I shall answer, That Wood being a Body full of Pores (except some which will not fwim in Water) and upon that account

account specifically lighter than Water, the Water by the Pressure of that which is incumbent, getting betwixt the Superficies of the Veffel and the Body immersed, causes it to rise, the Water which fucceeds it is is place making a more powerful Pressure against it, than its Specifick Gravity enables it to refult. And that Bodies Specifically lighter than Water will be thus buoyed up by it, will appear from the Hydrostatical Paradoxes hereafter to be laid down.

And tho' it be usually breed, that the Bodies imimmerfed are too closely contiguous to the bottom of the Vessel for the Water to infinuate themfelves betwixt; yet from the following Experiment it will appear, that were the contiguous Surfaces fo close, the positive Levity of the Wood would not be able to raise it; for two black Marbles, being so exactly polithed as to be as contiguous as possibly they might, we tyed a Bladder full of Air to the uppermost, and then causing them both to be immersed in Water, the positive Levity of the Bladder, would not cause the Bladder to rife; but as foon as by a fervant the uppermost Marble was gradually slipped half off the Polished Surface of the lowest, the Water which before was not able to infinuate it felf betwixt the Surfaces of the contiguous Marbles, and to separate them, presently caused the Bladder to rife with a confiderable swiftness and force, above the Surface of the Water: Which Event, that it did not depend on Nature's abhorrency of a Vacuum is evident, fince that would have an equal force when the Polished Surfaces were wholly contiguous, the Powet of Nature's abhorrency of a Vacuum being held



held by its Affertors to be unlimited. And that it was not the heaviness of the upper Marble, nor want of lightness in the included, appeared, since when the Surfaces of the polished Marbles were not contiguous, the Bladder was able to lift up a weight of fix or seven

pound, besides the Marble.

And to flew, that the Bladder might be raised by the Pressure of the Water, according to the laws of Hydrostaticks usually buoying up Bodies Specifically lighter than it felf. having pressed out the greatest part of the Air contained in a Bladder, I tyed a piece of Iron to it, and immersed it in a wide-mouth'd Glass. which was fo deep that the Bladder was totally immersed, and yet not far below the Surface of the Water, and this being convey'd into our Pneumatick Engine, when by exhausting the Air part of the Pressure was taken off, the Air in the Bladder expanding it felf, and takeing up more Room in the Water, and confequently becoming fo much more Specifically lighter, and the refistance of the Water which endeavours to buoy it up becoming respectively greater, it was together with the fuspended weight, raised to the Surface of the Water, and continued there till the outward Air was let in again ; and then the Air being contracted into its former dimensions, it subsided again. In which Experiment the politive Levity of the Air was not varyed, but only its relative and respective weight in reference to its proportion of Water, INV

And that Rarefaction alters not the politive Levity of Bodies, may appear from the following Experiment; for having oyled a Bladder. and when the Air was expressed, tyed it to the neck of a Vial, I found, that in the exhausted Receiver tho' the Air in the Vial was fo far expanded as to fill the whole capacity of the Bladder, yet the Vial neither role higher; nor fubfideded lower when the Air was drawn out or let in again.

CHAP. II.

New Experiments about the Preffure of the Air's Spring on Bodies under Water.

O shew that the Spring and Weight of the Air bath manifest effects on Bodies sepa-Butter rated from an immediate contact by the Interpolition of Water, I shall subjoyn the following Experiments.

EXPERIMENT II.

We luted the neck of a Vial, which was capable of containing above a point of Water, upon that pipe which conveys Air out of the Receiver into the Pump, which being done, we whelmed over this Receiver our large one, and having poured in a sufficient quantity of Water, we closed it up with the Turn-key, that no Air might get out that way, and then the Air being exhausted out of the Vial, it flew into a great many peices, the fides of the Glass being not able to relift the Pressure of the Air, that



that lay upon the Surface of the Water in the large Receiver.

EXPERIMENT IL

The greatest part of the Air being squeezed out of a Bladder, and the Bladder tyed to a weight, which kept it something below the Surface of Water contained in a wide-mouth'd Glas; this being convey'd into a Receiver, the Air in the Bladder expanded, as the Air on the Superficies of the Water was extracted.

EXPERIMENT III.

A Brafs Plug being fitted to a Cylinder which was closed with a Plate of the same Metal at one end; we put a Bladder half blown into the Cylinder, and placing the Plug upon it, with a weight of a Conical figure upon that; we poured so much Water into the Receiver in which it was placed, as covered the top of the Conical weight, but left the Ring which was fixed to the top of it, and which was fastned to the Turn-key by the help of a string; and things being thus ordered, when the Air above the Water was considerably exhausted, the Spring of the Air in the Cylinder raifed the Plugg and Weights a confiderable height, tho' the whole weight amounted to twenty eight pounds.

EXPE-

EXPERIMENT IV.

A Glass Vial being closed with Cement, and immersed in a deep Brass Cylinder of Water, this was convey'd into our Receiver, and when the Air which pressed upon the Water was drawn off, the Vial in the bottom of the Water was violently shattered in pieces by the Spring of the included Air, for want of a sufficient Pressure of the Air incumbent on the Water, to resist the force of that Spring.

EXPERIMENT V.

To flew that the Expansion or Rarefaction of Air increases not the positive Levity of Air, we suspended a Bladder half full of Air, with a Counterposic, at a ballance in our Receiver, and the when the Air was exhausted, the Bladder was sufficiently distended; yet it seemed to retain the same weight, whether dilated or contracted.

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CHAP. III.

New Experiments concerning an effect of the varying weight of the Atmosphere upon some Bodies in the Water. Communicated in the Transactions of Feb. 24. 1673.

Considering that the Pores of most Liquors of the Efcate of the are plentifully stocked with Aery Partification of the Efcate of the Atmo-differing of sphere may according to its several degrees of the Atmosphere may according to its several degrees of the Atmosphere may according to its several degrees of the Atmosphere may according to its several degrees of the Atmosphere may according to its several degrees of the Atmosphere may according to its several degrees of the Atmosphere may according to its several degrees of the Atmosphere may according to its several degrees of light according to the Atmosphere may according to its several degrees of the Atmosphere varyed in weight or degrees of Heat and Cold.

And it was easie to observe, that when the Heat of the Air raised one of these Bubbles, the Heat of the Sun-Beams would so rarise the Water included in them, as to cause some of it to get out, upon which the Bubbles emerged, but when those Beams were intercepted, the Water being condensed, and getting into the Bubble again, it would subside. But when their subsiding depended on the weight of the Atmosphere, if the Mercury in the Baroscope stood high, the Heat of the Sun would not raise the Bubbles.

N. B. 1. That .

N. B. 1. That the Bubbles not being all equally poised, sometimes one and sometimes two would rise, as the Air was heavier or lighter, and consequently capable of affecting the lightest only, or all.

2. The Success did not always answer, for when the subsiding depended on some occult cause, they would continue there, as if some airy Parts had infinuated themselves into the

Water.

3. The fittest time for these Experiments, and in which they best succeed, is in the Spring, the Air being more subject to vary in its Weight, as well as other things.

CHAP. IV.

New Experiments about the differing Preffure of beauty Solids and Fluids.

believe that the Air hath no fuch a confibelieve that the Air hath no fuch a confiderable Pressure on subject Bodies as we teach,
is, because they think it would be too heavy
for Animal Bodies to live or move under it;
but since we have positive proof of it, we may
as well doubt whether the Load-stone be endewed with an attracting and other Virtues,
because we cannot understand how they are
perform'd. Besides, Men being born under
such a Pressure, their Bodies seem not only actustom'd to it, but proportionably strong. But
could we suppose a Man born somewhere,
without



rithout the incumbent weight of an Atmophere, doubtlels fuch Bodies would not be fo

But it is urged by some, that were there such Pressure of the Atmosphere, it would cause Pain; but to this it may likewife be answered, that our Bodies being from the Birth accustomed to it, we only feel' Pain upon some new unaccustomed and additional Pressure; so when we are accustomed to wear heavy Cloaths, we are not sensible of their weight, nor are we fensible of the Heat of the Blood in our Heart, because it's habitual to those Parts, whereas it our finger be put into the Heart of a newly diffected Animal, we shall find it sensibly hot.

But further, from what I have elsewhere laid down, it appears, that a Cubick Inch of Air will be able to refift the weight of the whole incombent Atmosphere, and that a little quantity of Air relifts a further compression as well as a greater; and I have likewife shewn, that the Pores of the Parts of Animals whether fluid or confistent, are plentifully stocked with numerous Aerial Bubbles, which cause those Bodies to swell or expand in our exhausted Receiver. And as for those membranous and fibrous Parts which are not altogether fo porous, they are of to strong and firm a Texture, as to refift external Pressure upon that account. Belides, there is a great deal of difference betwixt the partial Pressure of a folid Body, and the Pressure of an Ambient Fluid, which presfes uniformly and is relifted either by the folidity of the Parts, or the Spring of those Airy Particles

Particles contained within their Pores. And that the uniformnels of the Pressure makes & less sensible, is evident, since it hath been oh ferved, that tho' the Atmosphere is so much lighter upon the tops of some high Mountains. as not to elevate Mercury fo high in a Baroscope by three Inches, as at the bottom, ver those that have been upon those Mountains tell us, that they perceived no confiderable difference in the Pressure of the Atmosphere above and below; nor are Miners fenfible of any great weight upon them, tho' in deep Mines in Mountainous Countrys; nor are Divers fensible of any Presiure when under Water; but that Air weighs in Air, and that Water weighs in Water, I have elsewhere made it evident; yet I don't think that a Diver is violently depresed by the weight of the incumbent Water, fince from what we have elsewhere delivered it appears, that if a Man's Body were of an equal pecifick Gravity with the Water, the fubiacent Water would fustain him, but his Body being heavier than an equal bulk of Water, the Surplusage of weight depresses it; for which Reason, in some Sea-Water, which is near of the Same Specifick Gravity with their Bodies, Diver find it very difficult to dive. However it is not a little strange, that at so great a depth as one hundred fathom Divers should not perceive a fensible Pressure, especially upon their Thorax and Abdomen : But I am apt to believe that the inadvertency of some of them, rather than any thing elfe makes them not take notice of it; or elfe the hafte which they rife and fink in; fince I have been told by fome,

that they have perceived a manifest Pressure when they link leisurely. And I was likewise told by another, that when he descended a most depth under Water, the Blood was squeezed out of his Nose and Eyes; and another who dired in a Leathern-case told me, that it was so much pressed against his Thorax and Belly, that he was sorced saddenly to come up a-

min.

But fince these Relations are not altogether to be relied on, I shall endeavour to give Reason why the Pressure is no more sensible; which I take to be the strong Texture of a Hu-Body, and the uniformity of the Pressure. As so the first, to what I have faid of the Reaftence made by our Bodies to external Preffire, I shall only add, that a Bladder being tyed upon the end of a Cylinder, about an Inch in Diameter, when the Air was exhausted, the incumbent Pressure of the Atmosphere was not the to break it, tho' when a Man's hand was placed there, he was not able to raise it till some of the Air was let in again, the Pressure which held his hand down being equivalent to Cylinder of Water thirty foot high. But to new the effects of an uniformPressure of Liquids ipon Solids contained in them, I shall subjoyn the following Tryals.

EXPERIMENT I, II, and III.

Having placed an Egg betwixt two Bladders half blown, in a Brass Cylinder, and cautiously put a Plug upon them, with as much weight upon it as amounted to thirty pound, I placed

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them all in a Receiver, and when the Air was exhausted, tho the expanding Bladders mul needs prefs equally against the Egg and the Plug. yet the incumbent weight was raised, and the Egg when taken out as whole as before; the weight it sustained in the Cylinder being not quite fo much as the weight of the Atmosphere. But tho' the Egg was able to fustain so much weight when preffed upon uniformly; yet Weights being successively laid upon the same Egg exposed to the open Air, four Pound weight crushed it in pieces. And by further Tryak we found, that an Egg-shell, which had all the Yelk and White taken out, as also a thin Glass Bubble, being placed betwixt two Bladders, as in the first Experiment, neither of them was in the least cracked.

EXPERIMENT IV.

To shew that what we have taught of the Nature of Fluids, will hold in Water as well as Air, if he Pressure be uniform, we enclosed an Egg in a Bladder almost full of Water, and putting it into the Brafs Cylinder, we heaped upon the Plug as many Weights as amounted to fevency five pound, yet the Egg being taken out, was as found as when first put in. In which instance it cannot be pretended, that the Egg bore no weight, by those that allow not Water to gravitate in Water, fince there was a confiderable Pressure made by Metalline Weights, which every body allows to weigh in Water. From this Experiment, and the other before mention'd, of an Egg being broke by a partial Pref-



Pressure, it appears, that the Strength of the Termre of a Humane Body, together with the Uniformity of the Pressure of ambient Water. may be the reasons why Divers feel no greater Inconveniency under Water; for the' their Therex may be a little more compressed than other Parts, yet that Part being naturally dilated and contracted, a little Pressure may make no fensible Alteration: But I have been told by Diver, that at a confiderable Depth, he perceived a painful Pressure upon the Drums of his Ears, 'till he contriv'd a way to guard them from that Inconveniency; the reason of which Phenomenon feemed to be no other, than that in that Part there was not an equal internal Preffure, to refift and counterballance the external Pressure of the Water.

CHAP. V.

An Invention for estimating the Weight of Water in Water, with ordinary Ballances or Weights. Communicated in the Pub. Transatt. of Aug. 16. 1669.

A Bubble about the bigness of a Pullet's Egg, with a long Stem turned up at the end, was heated; and, when the Air was most of it expelled, sealed up; and then being by a convenient weight of Lead immersed under Water, it was suspended at the end of a Ballance, and counterpossed; and then the Apex of the Stem being broke off with a Forceps, so much

Water got into the Cavity of the Bubble, a required four drachus and thirty eight grains to reduce the Ballance to an Equilibrium. Which being done, we drove out the Water by the help of a Flame of a Candle into another Glafs, which was counterposed, and we found that it weighed four drachus and thirty grains, which together with what was evaporated and lost, and the weight of the Apex, amounted to the weight first mention'd. So that from hence it appears, that Water weight as much in Water, as it does in the open Air; which according to the best Computation we could make, succeeded a second time in a larger Bubble.

As for the Objections which Mr. George Sinclair hath made to this Experiment, fince it is the Opinion of our Author, that he only differs from him in Expressions, I shall wave what he there fays, as not at all requilite in this Place; and shall only add what our Author hath faid, to explain what he means by Water weighing in Water, viz. That it gravitates or weight, in as much as it tends downwards, upon the account of its specifick Weight, tho' it does not preponderate, that is, the Parcel of Water weighed hath but an equal Tendency downwards with the Ambient Water, but upon an additional Weight it preponderates as much as the additional weight increases its Tendency towards the Center,

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CHAP. VI.

Hydrostatical Paradoxes made out by new Experiments.

DEfore I proceed to the Hydrostatical Paradoxes, I shall briefly intimate, that tho' I can readily affent to the Hydrostatical Conclusions laid down in Monfieur Pajchall's Difcourfe; yet as for the Experiments he makes use of to prove them by, I must own, I am not satisfy'd with them; fince he makes use of such as require that a Man should sit under Water fifteen or twenty Foot, with the end of a Tube leaning upon his Thigh. But he neither acquaints us how a Man shall be able to continue there, or how he shall discern the alterations in the Mercury or other Bodies, at the bottom. Besides, fuch Experiments as he proposes require Tubes twenty foot long, and Vessels as many foot deep, which are hard to be got in England; nor is it possible to obtain from a Tradesman. Brass Cylinders or Pluggs, made with so much Mathematical Exactness as he proposes.

Having therefore contriv'd a more easy way to demonstrate the Truths contain'd in the foregoing Paradoxes; before I proceed to examine them, I shall premise a word or two by way of Postulatum or a Lemma; which consists of three Parts: The first of which is, That if a Pipe open at both ends, and held perpendicular to the Horizon, have the lower of them under Water, there passes an imaginary Plais, which touching the Orifice of the Pipe, is pa-

rallel

rallel to the Horizon, and likewise, as to sense. to the upper Surface of the Water. To which it will be confount, fecondly, that as long as the Surface of the Water is even, the Water incumbent on this Plain will equally press on all the parts of it. But, thirdly, if there be a greater Pressure on one part of this Plain than another, as when a Stone preffes upon it, the Water which lyes under that Stone will be difplaced, as the Stone fablides successively, 'till it come to the Bottom. But on the contrary, if there be less Pressure on one part of that Plain than on another, the Liquor will be raifed on that part so high, 'till the Liquor on that part of the Plain gravitates equally as the Water incumbent on the other parts of it; which will appear from the following Experiments.

And first, If a Cylindrical Pipe open at both ends, be held in a perpendicular Posture, and the lower end be immersed three Inches in Water, the Liquid within the Tube having a free Communication, will be of an equal height with the external Water, and in thin Tubes, a little higher. But if Oyl be gradually poured upon the Water without the Pipe, the superficial Plain will have a greater Pressure upon it without than within, and consequently the Water under the Tube, sinding not so great a Pressure within the Pipe as without, it gradually rises, itill the external and internal Pressure upon the

imaginary Plain be equal.

What is contain'd in the following Paradoxes,
I shall proceed to them, as soon as I have laid
down the following Experiments, to shew Air

s not a Body devoid of Weight, as some Perimeticks suppose. The first is, that a Glass Bubble being blown; whose Capacity was short of two cubical Inches, it was instantly hermetically fealed, whilft hot; and when it was cool, being placed in a nice pair of Scales, and then the Apex of the Stem being broke off, the Air rushing in with a noise, caused the Bubble to preponderate half a Grain, tho' by breaking of the Stem under Water, it appear'd that the rarify'd Air remaining in the sealed Glass, posfes'd one fourth of its Capacity. Another time the same Experiment being tryed, the Air contain'd feem'd to weigh near three quarters of a Grain; and the Capacity of the Receiver being filled with common Water, it weighed Grains: So that allowing the Air contain'd to take up one fourth, and that the weight of the remaining Part was 1, probably the weight of the whole was about a Grain; and confequently the Water weighed little more than nine hundred times as much as an equal Bulk of Air.

PARADOX I.

Paradon

That in Water, and other Fluids, the lower Parts are pressed by the upper.

If in a Glass of Water, ABCD (see Plate See Plate 2. the second, Fig. the first) a Cylindrical Tube Fig. 1. be immersed, which contains Oyl of Turpentine; and that Oyl be suspended there, (by keeping the upper Orifice close, after it hath been such that our convenient height) 'till the Pipe is

Book V

is depress'd to a convenient Depth in the Wa ter : if the lower end of the Pipe BQ be immerfed 'till it reaches to the imaginary Surface GH, and the Oyl XQ prefies no more upon that imaginary Surface, than the Water with out the Tube, then the Oyl will be suspended there, and not be able to deprefs the Surface of the Water below it; but if the Surface of the Oyl in the Tube be much above the Water and it prefies more upon the imaginary Surface GH than the Water without, then it will make its way through that Surface, 'till the Oyl within and the Water without are brought to an & quilibrium again, fo that they both equally prefs upon the Surface GH; and the like will happen, if the Tube be raifed to the Surface DS. and gradually on to the Surface L M; for as the Pressure of the external Water grows less and lefs, as the imaginary Surface is nearer the top of the Glass, so the Oyl in the Tube growing preponderant, falls out at the lower end of the Tube, 'till the Tube TV being almost raised to the Surface L M, but a little Water pressing upon that Surface, the Oyl is almost wholly fallen out of the Cylindrical Cavity of it. But if instead of raising the Pipe PQ, it be depressed to the Position NO, the Water incumbent on the Surface E F on the outlide the Pipe, being more powerful than the Cylinder of Oyl W. A. which is only agriponderant to a Cylinder of Water leaning on the Surface GH, the Oyl must be buoyed up by the Preffore of the external Water, and the Space O.E. filled with Water fo that the Oyl betwixt Wit, and E O, being both sequiponderant to a Cylinder



lader of Water, they may equally press upon Serface E F with the Water on the ontide. And agreeable to what hath been faid it is, that he Cylinder of Oyl X Q will be fomething hove the Surface L M, when the Tube is only mmerfed to the Surface Q. Since Oyl of Turpentine being specifically lighter than Water, the Cylinder must be longer, to preis upon the Surface G H, equally with a Cylinder of Water, no longer than from the Surface L M to GH. And if a heavier Liquor than Water were made use of, the Surface X must be more above LM than in Water, otherwise it would not press equally upon the subjacent Surface. From whence appears the Truth of the Propofition, for if the Oyl be kept suspended at a different Height as the external Water is deeper, to countervail it; and if as it is raised from GH to IK, the Oyl in the bottom of the Pipe is prefled out, it must needs follow, that it is preffed down by the weight of the incumbent Oyl, fince then the furface of the Water IK, being not equally prefled upon from without, as by the Oyl, it is able to break that Surface and make its way out.

But before I proceed to the following Propositions, I shall subjoin the following Advertisements. First, What we say of the Pressure of Fluids upon one another, is to be attributed to heavy Fluids in general, except some reason appears for a particular exception in some Places. Secondly, That in slender Pipes the Surface of the Liquor within, is generally above the Surface of the external, Thirdly, Small Pipes are the fittest for these Experiments, be-

cause

cause in larger the emerging Oyl passing through the Water obscures the Light of what is defigned to be visible. Fourthly, We make use of Oyl of Turpentine rather than any other Liquor, because clear and colourless, and not apt to frain ones Cloaths; and as for the offensive Smell, that may be corrected with Oyl of Rhodium, or any other odoriferous Oyl, tho' any other Liquor may be made use of, that will not mix with Water. Fifthly, Oyl of Turpentine may be tinged with Copper, to render the Phenomena within more visible; for which reason we often employ a Decoction of Brafil instead of clear Water, or of Log-wood, or red lnk it felf. Sixthly, the Figure of the Glasses may be what you please, but the Pipes must be broader or longer as occasion requires. Seventhly, The Pipes are to be filled by facking up the Air to a convenient Height, and then stopping the Orifice above with ones Finger; but if it be too high, the Experimenter may let it out as he pleases, by admitting a convenient quantity of Air in at the Top, by gradually removing his Finger. Laftly, In fuch Experiments as require a confiderable disparity betwixt the two mingled Liquors, we may make use of Oyl of Tartar per Deliquium instead of Water, and Spirit of Wine instead of Oyl of Turpentine; these Liquors being not disposed to mingle with one another; and instead of fair Water we may make use of a filtred Solution of Sea-Salt, when the other is not eafily got. And when we have a mind to vary the Experiment, we may make use of Oyl of Turpentine along with the other two; and by depressing a Tube into



into them with Water in the bottom, exhibit very pleasing Phenomena.

PARADOX II.

That a lighter fluid may gravitate or weigh upon a beavier.

The truth of this is evident, finee all Bodies have a tendency towards the Center; by which they are always disposed to press downwards, tho' fometimes they have a respective Levity, as when a piece of Wood emerges in Water, yet nevertheless that relative Levity argues not that it hath no weight at all, fince tho' when a Men stands in a pair of Scales and lifts up a weight, notwithstaning the Ascent of the weight he will perceive a manifest tendency of it downwards.

But to make it more plain (See Plate 2d. See Plate 2 Fig. 2.) where supposing a Cylinder of Water Fig. 2. IG, to be immersed in Oyl of Turpentine to the immaginary Surface E F; the Water in the Pipe I H being heavier in Specie than the Oyl, it will equally ponderate upon the Surface E F as the lighter Oyl KELI, and if the Pipe be immersed deeper, the Cylinder of Water being not equiponderant with the extenal Oyl, the Oyl will, tho' a lighter Body in Specie, rife in the bottom of the Tube and buoy up the Water.

Again the Bubble X which confifts of a Glass See Plate 2. heavier than Water and Air which is lighter; Fig. 3. or partly of Water it felf which is specifically as heavy, as long as the whole aggregate is lighter



but if it grows heavier it will fink, and if any heavy Body presses upon it, which is specifically heavier than Water, by which the included Air may be compressed, the Bubble will subside, but when that Pressure is taken off, and the Air expands it self again, it will as soon emerge, the Water that was before sucked in being by that

means expelled.

But for a forther Confirmation of this second Paradox, I shall add the following Experiment, wit. That having put a Glass-Bubble pretty well poised, into a Tube filled within a foot of the top with Water, it swam there, till a good deal of Oyl of Turpentine was poured upon the Water, but then more Water being forced into the Bubble by the weight of the incumbent Oyl, it presently subsided; but when part of that Oyl was taken off, the spring of the Internal Air forcing the impressed Water out again, the Bubble presently immerged. And,

For a further Confination of this Paradox as well as the first, I shall add, that a Bubble swimming in a Tube, as in the former Experiment, tho' depressed to the bottom by a Wier, yet when that Pressure is taken off again it will rise up as before; but if it be held under Water till more is poured in, and till it rise about a foot above it in the Tube, the weight of the incumbent Water will depress it, but if that Water be gradually taken off, the Bubble will presently emerge.

If it should be asked why in these Tryals I did not make use of Oyl of Tartar per Deliquium, instead of Water? I shall answer, That in such

flender



sender Pipes as the first Experiment was made in, in the Oyl of Tartar flowed down one side, the Oyl of Turpentine would rise on the other; which makes me wonder that Monsseur Paschall hould teach, that if a Tube silled with Mercury be immersed sourteen foot under Water, if the Tube be sourteen foot long, the Mercury will not wholly run out; but continue to the height of a foot in the bottom of it; and I the more wonder at it, since probably the Impetus would make it descend; and since the like would not succeed with much more savourable tircumstances, betwixt Oyl of Turpentine and Oyl of Tartar.

PARADOX III.

Paradex 3:

That if a Body contiguous to the Water be altogether or in Part lower than the highest level of the said Water, the lower part of the Body will be pressed upward by the Water that touches it beneated.

This may be proved from what hath been delivered under the first Paradox, for whereever an imaginary Surface is beneath the real one, the weight of the Water being incumbent on all other Parts of the same Superficies, that part on which the immersed Body chances to tean must have a Proportionable endeavour upwards; and if that endeavour be greater than the specifick Gravity of the immersed Body is able to resist, then it is buoyed up; and tho' the Gravity of the immersed Body is fo great, as to over-power the tendency of the Water upwards,

upwards, yet the tendency of that Water is not therefore to be denyed, for as much as it in some measure resists the subsiding of that Body. And this may be confirmed by the Experiment tryed in the second figure, for as more Oyl is externaly poured on, the Water is impelled and buoyed up in the Pipe by the subjacent Oyl, which could not be, if the Oyl did not press against it beneath; and even when the Water and Oyl are in an Equilibrium, the latter presses upwards, in as much as it resists the descent of the Water out of the Tube. And the truth of this Proposition is equally true, whether we suspend Oyl in Water or Water in Oyl.

Spe Plate 2.

And that the Water makes a refistance to Bodies that descend in it, will appear from the following Scheme; for supposing the Pipe E F to contain Oyl specifically heavier than Water, and when the Oyl and Water without were in an . Equilibrium, the Pipe be raised, drops of Oyl will fall out but much more flowly than in the open Air, where if the drop G were not specifically heavier than the Water, it would not break the imaginary Surface of the Water H I. But further, it not only from hence appears, that fince as long as the two Liquors are in Equilibrium they are not able to remove each other out of their places; but from hence we may infer, that a Liquor of an equal specifick Gravity with Water, being placed in any part of that Liquor, would remain in the place affigned.

But to illustrate what we have faid, of Water obstructing the descent of Bodies heavier than it felf, I shall add, that if twelve ounces of Lead be counterpoised in the Air, when the Leid is let down below the Surface of the Water, the Scale in the Air will manifeltly preponderate; which shews that the Water hinders the descent of the other. And the resistance of Fluids to the lower fuperficies of Bodies may be further confirmed by observing, that Bodies specifically lighter than Water are raised by it, s Wood and drops of Oyl; the Reason of which feems to be this, that there is a greater Prefure upon the lowest part N, than upon the upper part of the drop M, because that upon all the Surface R L there is an uniform Pressure of the Water A K. B L, and upon all the Parts of the Surface H 1 there is a greater weight of Water A H. B I, except at the part N, for there the Oyl G, being not fo heavy as fo much . Water, it is confequently unable to refift the acent of the Water beneath it, for which Reason it is buoyed up ; and the case being the same with that and any other Parallel Plain, where, ever it is in its afcent, it must be by the same Region gradually raised up, for the Oyl being presed against by two Pillars of Water, the one above and the other below, and the lower being longer by the thickness of the rising Body, than that which lyes upon it, it must confequently be buoyed up, and more or less fwiftly as the lower Basis presses more or less on the subjacent superficies.

And

And for the like Reason when two pieces of flick of a different length are immerfed in Water; the longest rifes the fastest, for # O P were two foot high, and Q R but one and both refted upon the fame imaginary Plain the one hath a Pillar of Water a foot longer to relift its riling than the other, and as the emerging Body rifes flower as the proportion be twixt the upper and the lower Pillar of Wa. ter is less; fo thence may be deduced a Resin why in fome Liquors, whose whiteness depends on the intermixture of drops are fo long atiling. the minuteness of them rendering the difference of the upper and lower Pillaf of Air incons derable, but as these drops by moving up and down unite into larger, the difference grow ing more confiderable, they are accordingly buoved up in less time, and swim upon the ton of the Water.

Plate 2.

See Fig. 5. And for the same Reason, that these Bodies float upon Water, a Cobick Inch of Wood is by its specific Gravity only so far depresed into the Water contained in the Vial A B. GB. sill the Water about it makes an equal Preffi npon the imaginary Surface X W. and blos the Wood is not fo heavy in Specie as Witte therefore partois kept emerging above the fe perficientific, world reits out be

But to fliew further, that the weight of a floating Body is equal to as much Water, a its immerfed Port takes up the Room of, I'll Subjoyn; that having placed several Marks upon the Surface of a floating Glass and, when it was taken off the Water, put just so much Water into it as filled it up to those Marks, by that

means

means I found, that the weight of the Water which was sufficient to fill the space possessed by the floating Vessel, below the Surface of the Water, was equal to the weight of the whole floating Vessel, and all that was contained in it. And the same end may be obtained another way, wiz. By first filling a Cistern or Pond with Water, by a Vessel of a known capacity, and then having emptyed it again; for if the Vessel be placed in that Cistern or Pond, and Water put into the Cistern again till it floats the Vessel, and fills the Cistern or Pond full, as much as it falls short of the weight of Water first contained in the Cistern, so much is the weight of the floating Body.

PARADOX IV.

That in the ascension of Water in Pumps, &c.
There needs nothing to raise the Water, but a competent weight of an external fluid.

The truth of this Paradox sufficiently appears from what hath been before delivered; however to make it plainer, if possible, I shall add, that if a tinged Liquor be sucked up about an lach into a Tube, and whilst the upper Orifice is covered with ones Thumb, it be depressed in Water till the superficies of the external Water is above the Surface of the internal, and then a considerable quantity of Oyl be poured upon that, and when ones Thumb is taken off the upper Orifice of the Pipe, the external Fluids will by their Pressure, raise the tinged Liquor above the Surface of the Water, tho' not V 2

quite so high as the Oyl: From whence it appears, that a Liquor may be raised in a Tube by the Pressure of an external shuid, and that lighter than it self in Specie, which may illustrate what we have said of the rising of Water in Pumps, where by the Pressure of the Atmosphere the Water is buoyed up, when the Pressure of the incumbent Atmosphere is taken of the internal superficies by the rising sucker, and makes way for the Water to ascend with

in the Pipe.

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I took likewise a small Tube, whose Diameter was the fixth part of an Inch, and having immersed it an Inch in Quick-filver, I put my Thumb upon the upper Orifice, and kept it there till I had immerfed the Tube eighteen Inches in Oyl, by the weight of which pressing against the Quick-filver, it was not only kept from falling out of the Pipe, but raifed a little, and & when the Tube was raifed fome of the Mercury would fall out, so when it was depressed the Mercury would be buoyed up, by the greater weight of the external Liquor upon it. And indeed that the Water in a Pump may be raifed by the Pressure of an external fluid, will appear more fully to him that shall consider, that in the Torrecellian Experiment the Pressure of the external Air is able to raise Mercury in a Tube twenty nine or thirty Digits, which is equiposderant to a Cylinder of Water thirty three or thirty four foot high.





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PARADOX V.

Paradex V.

That the Pressure of an external fluid, is able to keep an Heterogeneous Liquor suspended at the same beight in several Pipes, the those Pipes be of very different Diameters.

This is evident from what is represented in See Fig. 6. Fig. 6. Plate the second, for if the Orifice of Plate 2. that Vessel A B C D be closed up with a Cork, and that Cork have four holes, in three of which the Pipes are fixed and in the fourth the Tunsel, and if, when so much Water hath been poured in as reaches to the Surface E F, Oyl be poured through the Tunnel till it reaches to the Surface G H it will depress the Surface of the Water down lower, and the Oyl not being the to get into the Pipes L. M. N. by its weight, it will cause the Water to rise to OPQ, the Surface of the Water, which before rested at EF, being depressed down to IK, upon which imaginary Surface the Water contained in the Tubes, answerable to their Bulk, making an equivalent Pressure with a Cylinder of external Oyl of the same Bore, the Water must consequently be buoyed up to the fame height in all, except the last Pipe be very small, but the difference on that account being eafily diftinguished,it will be no difficult matter to make an allowance.

N. B. when the Oyl is poured through the Tunnel, it will be requisite to put some Cotton Wool in it, to break the force of the falling

stream, lest the violence of it should prejudice the Experiment.

PARADOX

Paradox

If a Body placed under Water, with its uppermost Surface parallel to the Horrizon, bee much Water soever there may be on this or the fide above the Body, the direct Pressure fustained by the Body (for we now confider not the Lateral or the recoiling Pressure, to which the Body may be exposed, if quite environed with Wan) is no more than that of a Column of Water, having the Horizontal superficies of the Body for its Basis, and the Perpendicular depth of the Water for its beight.

And fo likewife,

If the Water that leans upon the Body be contained in Pipes open at both ends, the Pressure of the Water is to be estimated by the weight of a Pillar of Water, whose Basis is equal to the lower Orifice of a Pipe, (which we suppose to be parallel to the Horizon) and its beight equal to a Perpendicular, reaching thence to the top of the Water; the the Pice be much inclined towards the Horizon, or tho' it be irregularly shaped, and much broader in some Parts, than the faid Orifice.

As for the first part of our Paradox, it is proposed by Stevinus in more general Terms, and thus demonstrated, (See Fig. 7. Plate the fecond) where, supposing A BCD to be a folid Rectangular figure of Water, whose Bafis EF is parallel to the Horizon, and whole height



height G E is a Perpendicular from the Surface of that Water, the bottom D E, E F, and F C cannot be charged with a greater weight than what is respectively Perpendicular, became none of them can receive an Additional weight from the Water Collaterally, but it must diminish the weight of Water Perpendicularly incumbent on that other bottom, else there must be a greater weight upon the Basis D E F C, than is contained in the Surface

AB.CD, which is impossible.

To which instance of the learned Stevinus I shall add the following. For if Oyl be fuck'd up into the Pipe represented by Fig. 8 Plate the fecond, and when it is at a convenient height in the longer Leg, you nimbly stop the upper Orifice, till it be depressed so low into the Water, that the Oyl is but little above the Surface of the Water, it will rest near that station, when the upper Orifice is unstopped; and if it be depressed lower than that, the weight of the incumbent Pillar of Water will force its way into the Pipe, so far as answers the weight of a Cylinder of Water of an equal Bore with the Oyl contained in the Pipe, and on the contrary, if the Pipe be elevated above its first fation, as much Oyl will rife out of the Pipe and emerge, as answers in weight to the part of the incombent Pillar of Water removed by that means from gravitating upon it. And to this I shall add, that tho Water is not contained in Pipes, yet it presses as regularly upon subjacent Bodies as if it were; which will be evident, if a Vessel of the shape of the Funnel delineated in Fig. the 6th be imployed, for the Fig. 1.

the Liquor contained in the small Stem of the will be able to fustain the whole incumbent Was ter: In confirmation of which we made need fuch a Veffel, as Plate the third, figure the first represents and filling the parallel Leg with Orl. and the other as well as the Ball with Water. the Oyl was elevated no higher in the longer Leg, than if the less Leg had been an uniform Tube of the same Diameter; and when the Experiment was reiterated with Oyl in the Ball, and Water in the long Leg, the weight of that Ovl was not able to raise the Water in the long Leg to an equal superficies with it self; the Liquors in both these Experiments which was contained in the capacity of the Ball, being fultained by the concave fides of the Glass, And the like Experiment being tryed with Quick-filver, which was poured into the shorter Leg C D, till it rought almost to the bottom of the Ball, and as high in the longer Tube A B, upon an affusion of Water into the longer Leg, the Mercury was buoyed up into the Ball, till it rought to H E G, where if more than what was Perpendicularly incumbent on the Tube C had pressed upon it, the Water would not have been able to keep it at such a height.

See Plate 3. Fig. 2.

But to confirm the fecond part of our Paradox, we made use of a Glass, such as Plate the third Fig. the second represents, and having filled the Glass half full of Water, we stopped it with a Cork, in which the Pipes there delineated were fixed, and likewise the Tunnel, the bottom of each of the Pipes, being each immersed considerably in Water, and



then pouring in Oyl through the Tunnel, we observed, that the Water was elevated to an equal height from the lower superficies of the Orl which pressed on the Water; in which Experiment, tho' the Pipes contained more Water by being included, yet that Water preffed no more upon the imaginary Plain, than an ered Pipe of equal Bore with the lower superficies of the Water contained in it would have done. And if Oyl of Turpentine be poised in a Pipe in an erect Posture, and then by inclination s greater portion of it brought under Water, yet the external Water will raise the Oyl contained in it; and the fame was evident, when Orl of Turpentine being contained in three Pipes of fuch figures as Plate the third Fig. the See Fig. 3. third represents, for in all such cases, where Plate 3. the Pipes are in an inclined Posture, or some Parts of them larger than ordinary, part of the weight of the Liquors contained weigh upon the fides of the Vessel, and no more presses upon the subjacent Liquor, than is answerable to an erect Pipe of equal Bore with the lower Orifice, and of equal height with an erect Tube, answerable to the length of one end of that Pipe from the other.

To make out what Stevinus hath afferted, viz. That if a Cylinder of Water be placed upon a subjacent Body, the Basis will sustain a weight equal to that Circular Basis, and to the Perpendicular height of it, we provided a Veffel of Laton, of the figure represented by See Fig. 4. Fig. twelve Plate the third, which being furnished Plate 3. with a close bottom CD, made of a flat piece of Wood, covered with a foft Bladder,

and

and greafed on the lower fide near the edges, that leaned on the rim of Wood G H, contiguous every where to the infide of the Latten, that it might be easily lifted up from off the rim. and yet at other times lye fo close upon it. that the Water should not be able to get out between them. To the midst of this bottom was fastned a long string, for a use to be hereafter mention'd; the Instrument being thus prepared, the Water was poured in at the top of the Pipe A B, which prefling upon the falk bottom C D, against the subjacent rim G H, contributed to render the Vessel more close, and to obstruct its own passage, whereupon we tred the upper end of the ftring I K to a beam, and put fo many weights into the opposite Scale, as were sufficient to raise the false bottom CD from the rim G H. And then deducting from that weight, the weight of the false bottom. and the Water contained in the broad Cylindrical Box B E C H. G D F, we found that the Preffure, which was made upon CD was much greater than what reading Stevinus would make one expect, and than all the Water contained both in the Pipe and Cylinder would have been, had it been contained in an uniform Cylinder.

PARA-



PARADOX VII.

Paradon

Lateral Pressure from the fluid; and that increased, as the depth of the immersed Body below the Surface of the fluid increaseth.

This appears from what is represented by See Plant 3: Plate the third, Fig. the fifth, where Oyl be-Fig. 5ing sucked up into the Pipes G F K, and they
infliciently immersed in the Water contained
in the Vessel A B C D, so that the Surface of
the Oyl I K, may be but a little above the Water, the Imaginary Pillar of Water H G will
suspend it there, but if the Pipe be raised, the
Oyl becoming too heavy to be kept up by so
hort a Cylinder, the incumbent Cylinder will
force it out of the Orifice G, but if the Pipe be
further immersed, the Water will raise the
Oyl in the Tube, and fill part of the Cylindrical
cavity below it.

To this Experiment I shall add, that having see Plate 3. shopped the Mouth of the Vial ABCD, repre-Fig. 6. sented by Fig. six, Plate the third, with a Cork and Cement, and bored with a hot Iron, a hole to receive the Pipe G H, and the other E F, I shopped the Orifice G with a Cork and Cement likewise, and then pouring in Water through the Pipe E, till it rose to the Surface I, the Bubble X was so nicely poised that it swam, but as soon as by pouring in more Water the Surface was raised to K, the Bubble X subsided to the bottom: From whence it appears, that the whole Water contained in the Pipe E, presses

upon

upon the whole Water within the Glass, other wife it could not compress the Air in the Bah. ble, and make it fint; and likewise that it not only presses upon that subjacent, but likewise upon those Parts that are latterally situated in Respect of it. And that not only the upper Parts of the Water, but even the Cork that is below the Surface of the Water I, is preffed by the weight of it, and obliquely too appears, since if the Orifice G be not closely stopped, the Water will be raised through it, and if instead of a Cork and Cement, it be only flopped with ones Thumb, one may perceive an evident Pressure of the Water against it. And that the fubfiding of the Bubble depended on the Pressure of the Water above it appeared, fince if part of the Water was poured off, by inclining the Vial, it would present emerge again.

And one thing in this Experiment worthy our notice, was, that if the Glass A B. CD was not wholly filled, but the space betwirt L M filled with Air, yet the Pressure of fuch different Fluids may be so easily communicated from one to the other, that the Bubble would descend equally as if it were filled with

Water.

PARA-

PARADOX

That Water may be made to depress a Body lighter than it felf, as well as to buoy it

The truth of this Paradox will be easily made out by the following Experiments, for if a Glass Syphon, of the Figure represented by Fig. 7. Plate the third, be filled from H to I with Oyl of Turpentine, and immersed in the Glafs A B C Ditill the Orifice A of the shorter Leg be under Water, if then the Orifice E be unflopped, and the whole Tube EIFGH be depressed gradually, the incumbent, Water HK will press the Oyl out ofthe shorter Leg H G, into the longer E F. And,

For a further confirmation of this Paradox. s well as the foregoing, and the fecond, I shall subjoin; that having provided a Pipe of the Figure represented by Fig. 8. and sucked so See Fig. . much Oyl into it as filled the space L M N P, I immersed it in Water, and upon the opening the Orifice O, as the Pipe was gradually depressed, the Oyl was pressed out of the Pipe L M to N. and from thence to what height I pleased in the Pipe O P N.

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and him by Cooks plant of the low less in C. A. straticeps afrag as aged been in topics and

See Plate 2

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PARADOX IX.

That whatever is faid of Positive Levity, a parcel of Oyl lighter than Water may be kept in Wa. ter, without ascending in it.

Confidering that fince the Surface of a Veffel of standing Water is (Physically speaking) Horizontal, the Water that preffes against the lower part of the immerfed Body must need be deeper, than that which preffes against the upper, and that this is the Reason why Bodies lighter than Water emerge, I concluded, that if the Water upon the upper Surface of Oyl in a Tube could be fo high as to ballance the Preffore of that Water below, Oyl might be fulpended betwixt two Parcels of Water. To try the Refult, I fucked an Inch of Water into a Tube, and by stopping the upper Orifice, and by that means folloending the Water in the Tube, I removed it into a Vessel of Oyl, and then opening the upper Orifice till an Inch of Oyl was broyed up into it, I removed it again into a Vessel of Water, and immersed it so far in that, till the Water below the Oyl was equal in height to the Water above it, in which station the Cylinder of Oyl and Water being equal in weight with the Pressure of the external Water, the Oyl Q. R. was suspended betwixt the Water S. R. and that below it P.Q. the Surface of the Water in the Pipe T. S. being so much above the Surface of the Water A D. as was requifite to make the Oyl and Water contained in the Pipe to press equally on the the Surface G, H. with the external Water, as Plate . Fig. 1. represents.

PARADOX X.

Paradox X.

That the Cause of the Ascension of Water in Syphony, and of flowing through them, may be explained without having recourse to Nature's Abborrency of a Vacuum.

To demonstrate this, we provided a Glass See Plate ? Tube A B. C.D. of a convenient wideness, Fig. 2 and half a yard or more in depth, as also a Syon with two Legs F K, and K G, to which n joined a Pipe E R, and to each of the Legs of that Syphon we tyed a Glass Pipe, sealed at the bottom, and having Water contained in each, to the height there delineated. Things being thus prepared, Oyl of Turpentine must be poured into the Tabe A B. C D. fout that it may not take up too much of the Oyl, the bottom of the Vessel to X T, may be filled with Water) till it reaches above the top of the Syphon F K G, and then by the weight of it the Water in the Pipe will be raifed through the Syphon, and run into the lower Vellel H. In which Experiment the Water is raifed through a Syphon by pressure, tho' at the fame time there be a free communication of Air through the Pipe E K, without danger of a Vacuum. In which Experiment, if the Reason be asked, why the Water does not rather run out of the Bipe H, into G, than the contrary? It may be answered, That tho' externally the Oyl is deeper upon the surface of the Water

Water in the Pipe H, and confequently preffes more upon it, yet the Tube G, on the other fide, instead of having that pressure of Oyl, hath a Cylinder of Water of an equal length, which being heavier than Oyl, raifes the Water out of that Tube more forcibly than it is raised out of the other. And for the like Reason, when once the Water is raised in Syphons, tho' there be a longer Cylinder of Air upon that end which is immersed in the lower Vessel, yet there is a greater weight on the other, because besides the incumbent Atmosphere, there is a considerable Weight of Water: But if the Syphon be bove 34 or 35 Foot high the Water will not flow through it, the pressure of the external Air being unable to raise Water to such a height. And one thing observable in these Er periments is, That if when the Water is running through these Syphons, a small hole be made upon the top of a Syphon, the Air preffing upon the Water within the Pipe as well as without it, it will cease to run, tho' the hole be no bigger than one made with a Needle; which hole if it be stopped with a Needle, the preffure of the external Air will by that means be taken off, and the Syphon be rendred fit for भीत है जिस्कृति है है

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tan or of the Bipe A, into G, that the corpunit to Oyl Is expense of that the exter-

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PARADOX XL

That a Solid Body, as ponderous as any yet known, the near the top of the Water, it will fink by its own weight; yet if it be placed at a greater depth, than that of twenty times its own thickness, it will not fink, if its descent be not affifted by the weight of the incumbent Water.

To demonstrate what is contained in this See Plate 4. Paradox, we must fill the Glass A B C D. (fee Plate the 4. Fig. the third,) almost full of Water, the length of it being near three Foot; in which Water, if we suppose the Weight EF to be placed upon the furface G H, it will fink by reason of its specifick Gravity, the Water incumbent on other parts of that Plain being not equiponderant, but if we suppose it to be placed upon the Surface I K; the Pillars of Water being above nine times as thick as it, they will counterballance it; for which Reason were there no Water upon it, it would subfide no further; and were a method contrived to keep the Water from prefling upon it, the like would happen supposing it to lean upon the Surface L M.

And to flew, that were the weight fo depresed free from incumbent Water, it would not subside, I shall add the following Experiment; let then the Brafs Body E F, (fce Plate See Plate 4 Fig. 4) be the cover of a Brass valve, the Fig. 4 valve being fastned with Cement to the Glass Pipe O P, the Body E F, must by pulling a hair fired to the button of Valve Q close the Orifice

of it, and then it being convey'd under War a foot deep, the Cement and fides of the Gle OP, will keep the Water off the upper put of the Body E F, and confequently the imetnary Surface V W will only be prefled upon by the fole weight of the Body E F, but the other Parts of that Surface by the incomber Cylinders of Water, fo that the Body EF will be bore up without the affiftance of an thing else but the Water buoying up againfig. but if the Tube be raifed till the Body EFk above the Surface I K, and near XT, the weight of it being greater than the weight of the incumbent Pillars of Water, the Body will be no longer supported; but if upon the first immersion, when the Body E F is let downto the Surface R S, a weight L be fuspended a it, that will not be able to fever the Body from the Valve; from whence it appears, the there is no need in our Phylico-mechanical Experiments to fly to a Fuga Vacui to explain the Reason why two exactly polished Marbles when contiguous are so hard to be separated. To what hath been faid under this Paradox, I fail add, that when the weight L is suspended at the button Q, the Body E F will be feparated before it rifes to the Surface I K.

APPENDIX L

Objection Objections to evince that the upper Parts of War pered. ter press not upon the lower, answered.

> The first Objection is, that if the upper Parts of the Water presed upon the lower, the low-

would be condensed; but to this it is anforced, that Water confisting of Parts tho' ate, yet very folid, it does not therefore low, fince in a heap of the powder of Dianonds, the lower are no more compressed on the superficial ones,; besides it hath not been found that Water was capable of being compressed by any force we could use. And the it be further urged, that Plants grow in the Sea without being depressed, yet that hapbecause the Pressure is not only incument but Collateral likewise, and so contributes to fostain it, and the rather because the Collateral Pressure is greater than the incumbent.

Another Objection is, that a Bucket of Water weighs no more when full in Water than the Bucket it felf out of it, nor so much. But the Reason of this is very plain, for suppoing ABCD to be a Well, (See Plate the see Plate 4. which is contiguous to the Plain I K, is suspended by the string E F, the Water in the Bocket 6 (if it be made of Wood which is lighter in Specie than Water) and the incumbent Pillar of Water not pressing upon the Surface H equally as the Water on the Surface I K, the Water below must buoy it up. And tho' the Bocket was made of something heavier than Water, yet the whole weight of it will not be perceived by the hand above, but only the Surplafage of weight which furmounts the weight of an equal bulk of Water. And tho' the School-men tell us, that this Phænomenon depends on the indisposition of Water to weigh in its own place, yet I have found, that Lead being

being convey'd into melted Butter contained in a wooden Box, and that being suspended in Water by a Silken-thred at the end of a ballance we observed that this was as much indisposed to weigh as Water in Water, no more weight than what furmounted the weight of an con bulk of Water, being made sensible by the ballance: But when it was partly raifed ou of the Water or wholly, a greater weight was requifite to counterballance it ; for impoling, that part of the Bucket N to be a bove the Surface of the Water L M, a great force is requisite to sustain it, the weight of Water incumbent on the Surface P Q being not able to ballance it, and confequently the bottom of the Bucket H, will fcarce be pressed upwards half so strongly as before. But if the Bucket be raifed to O, the Water being not at all contiguous to it, cannot contribute to the supporting of it.

All that is further contained in this Appendix, being only a Repetition of what hath been already delivered on this subject, I shall pass

it by as needless to be repeated again.

APPENDIX II.

Wby Divers, and others who descend to the bottom of the Sea, are not oppressed by the weight of the incumbent Water.

From what hath been already delivered it appearing, that Water weighs in Water, and consequently presses upon Bodies contained in it,

I shall therefore, before I propose my own opinion, briefly take notice of the follow-

And first Monfieur Des Caries tells us, that See Plate 4. if the Body of a Man were placed in the bot- Fig. 6. tom of the Vessel B, fo as to stop the Orifice A he would feell the weight of the Water CB A incumbent on him, but if he were placed at B, he would not be sensible of that weight, because should his Body descend, the Water betwixt B and C would not descend with him, but supposing the Orifice A to be flopped with a folid, that would feel the weight of the Water, because it hindred the descent of the Water betwixt B and A, but fince the Principles already laid down overthrow the foundation of this Explication, I shall only add, that were the matter of fact true, the Resson would be, that when his Body was at 4, the Man would fustain the weight of the incumbent Water, without any subjacent Water at A, to buoy up against him, whereas at B, the subjacent Water buoys up as much as the other presses down or more.

But Stevinus, Hydrostat. Lib. 5. Pag. 149. lays, Omni Pressu quo corpus dolore afficitur, pars aliqua corporis luxatur, fed isto Pressu nulla corporis pars luxatur, isto igitur Pressu corpus dolore nullo afficitur. Sed Exemplo clarius ita intelliget, efto ABCD, aqua cujus fundum DC in See Plate 4 quo foramen E babeat Epistomium sibi insertum. Fig. 7. on dorso incumbat bomo F, que cum ita sint, ab aqua pondere ipsi insidente nulla pars corporis luxari poterit, cum aqua undiquaque equaliter wgeat.

Which

Which folution might hold, if the question was only why the Body of a Diver is not preffed down to the bottom of the Sea. But as for what he fays, viz. That the equality and uniformness of the Pressure makes it less sensible I am of his opinion, for the' in the Air the Prefure of it is not perceivable for a like Reafon, yet if ones hand be applyed to the top of a Receiver, and the Air exhaufted, the Pressure of the incumbent Atmosphere will cause a fenfble Pain.

Fig. 8.

And to shew that the uniformity of the Preffure, and the firmness of the Bodies of Diver, may enable them to bear the Pressure of the Water, I shall add, that having included a Tad-pole in an Instrument, fuch as Fig. 8. Plate the fourth describes, the Plug was so far depressed, that the Air in the end of the Pipe was compressed into an eighth part of the space it possessed before, so that the Pressure upon the Water was equal to the weight of a Cylinder of Water three hundred foot high, yet the Tad-pole moved up and down as nimbly as before, being not at all indisposed, tho' its Body appeared to be compressed into less room than before.

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CHAP. VII.

An Hydrostatical discourse &c.

LL that is contained in this discourse, being chiefly aRepetition of what hath been before divered in other Parts of the Author's Works, ad now only repeated to obviate some Objection of Dr. More's, and the truth's laid down by our Author in his Hydrostatical Paradoxes, and Phylico-mechanical Experiments being fo plain, nd these Objections so trivial, it would but be sedless to encrease the bulk of the Book, with that may with more Reason be avoided.

CHAP. VIII.

A me Effey Instrument, and the Hydrofatical Principle it's founded on, &c. Communicated in the Transactions of June 1675.

The first Section.

Shrping the occasion of making this Instrument, and the Hydrostatical Principle it's founded upon,

TAving several years ago made use of a Bub- Anem Hy-Declick Gravity of Metals, by its easie or more Infrument and its uses difficult immersion with them, I applyed it like-proposed.

wife to estimate the weight of other Solids, by observing how Solids suspended at this Bubble would depress it variously according to their specifick Gravities; It being a general Rule in Hydrostaticks, that any folid Body in Water loses so much of its weight, as a parcel of Water of the same Dimensions would weigh in the Air, so that Gold being specifically heavier than Copper, it must lose less of its weight in the Water than Copper; because proportionably the Ignobler Metal possesses the space of a greater quantity of Water, whose weight. by weighing it in that fluid, is lost in the weight of the Body suspended at the Bubble. And confequently an ounce of Gold must cause that Bubble to be immersed deeper in Water, than an ounce of Brass or Copper would, the Brass by Reason of its larger Dimensions losing more of its weight than the Gold.

The fecond Section.

Describing the Construction of this Instrument.

This Instrument may be made of any Metal or other matter, which will float in the Water, without foaking it in, but the best for the uses hereafter mentioned are those made of Glass; tho' they are not so lasting as those that consist of Copper or Silver.

This Instrument is made of three Parts, a Ball, the Stem, and that which holds the Pipe, The Ball consists of two Metalline Plates, each of the fashion of a Convex Glass; and the Cavity within must be so large, that the Air contained





will keep the whole Stem from finking under Water; If the Ballast which is to keep the Vessel immersed in an erect posture is to be contain'd within the Vessel, the Stem ought to be hollow, but otherwise to consist of a small Cylinder without any Cavity, and of a convenient length.

The Inftrument I employ for Guineas hath it Ball as big as a Hens-egg, and the Stem about four or five Inches long, being soddered on to a hole in the Centre of the uppermost Convex part of the Ball; and to the Centre of the lowermost is fixed a piece of Wire to lay the Guiny upon, or a screwed stirrup to fix

it in.

If you have a mind to try pieces of Gold of greater weight, the stirrup ought to be fixed to a small Cylinder, upon which several pieces of Metal being fixed, and having holes in the middle, that they may be put on or taken off as occasion requires, the Instrument may be adjusted to any piece of Gold, tho' twice or thrice

as beavy as a Guiny.

To adjust this Instrument for the use of Guineas, it must be lightned by the use of a sile, or made heavier by the addition of Ballast, that it may be sufficiently immersed in the Water without sinking, and then a mark being fixed on the Stem at the Surface of the Water, a piece of Brass must be substituted in the place of the Guiny of the same weight, or a grain or two heavier in the Air, and a mark set at the Surface of the Water, when it is immersed by that weight.

In which method of adjusting, the following Particulars are to be minded.

First, the Guinea must be placed exactly with its middle in the fcrew, that it may not incline the Tube, but let it stand erect.

Secondly, Quick-filver Ballast in Metalline

Instruments is apt to dissolve the fodder.

Thirdly, the marks may be made of chewed Maftick fixed in finall holes; or by fixing a Silver or a Golden Wire in a nick made round the Stem.

Fourthly, one of the heavyest Guineas is to be made use of in adjusting this Instrument, and care must be taken that i of an Inch be left above the Water, because all Waters themfelves are not of an equal weight, yet those circumstances vary not the success, since the difference in the immerging this Instrument in feveral Waters, is in confiderable in respect of the difference betwixt a piece of Brass and Gold of an equal weight in the Air, it being an Inch and three quarters.

Fifthly, before we can determine by this Instrument whether the Gold be good, it must be weighed in the Air, to fee whether it be of a just weight, and then this will discover whether it be genuine, for otherwise we may think the Metal not good, when it only wants

weight in the Air.

The Explication of the Figures

See Plate 1. Fig. 1. A B. The Stem or Pipe. C E. The two Parts of the Ball foddered together.



- B C D E. The Ball it felf.
 - F. The fcrew,
 - 6. The stirrup somewhat out of its Place.
 - H. The mark to which Copper of the weight of a Guinea in the Alr depreffes it.
 - I. The mark to which the Gold finks it.
- He 2. The screw by it felf to be taken off or put on the undermost Stem of the Instrument.
- Fig. 3. The Perforated Plates to be put upon the lower Stem as ballaft.
- Fig. 4. The lower Stem with a Perforated Plate upon it.
- Fig. 5. The stirrup which my be made use of inftead of the fcrew.
- Fig. 6. A. B. C. The Glass Instrument.
- D D D. The Coin supported by four Horfe-hairs.
- Fig. 7. The undermost Stem of a Glass Instrument, to which a screw is fastned with Horse-hairs or otherwise.
- Fig. 8. A B C D. The Instrument for estimating the specifick Gravity of Liquors.
 - E E The Quick-filver or Water employed as Ballast.

The third Section.

Representing the uses of this Instrument, as re-

The first Use.

Is to distinguish true Guineas from Counterfeit.

The second Use.

In examining a piece of Gold lighter than a Guinea; so much Ballast may be added as will make that amount to the weight of a Guinea, and if the Gold be heavier, so many of the personated Plates must be taken off the Stem, that the Instrument may not be sunk by it, and when a Coin but a little heavier than a Guinea is to be tryed, it may be convenient to place a personated Plate upon the upper screw, so that it may be upon the Ball, and be taken off, or lightned with a file as occasion requires.

That several pieces of Gold may upon some occasions be fix'd at once, the aperture of the screw ought to be wider, than what will just

admit of a Guinea.

If the Instrument be well proportioned, so that a piece of Gold a little heavier than a Guinea, may not depress it under Water; it may be examined without altering the weight of the Instrument.

. And



And scording to the method above laid down, a half Guinea may be tryed by placing atrue half Guinea with it in the screw.

The third Use.

This Instrument may be adjusted to try Silver Coins which are lighter than half a Crown, by weighing Silver in it, and marking the Surface of the Water upon the Pipe, and then observing what difference there is betwixt that, and an equal weight of an ignobler Metal in the Air. And tho' several Instruments would be more convenient for the trying of these different Metals, yet by altering the Ballass Plates, one may be made to serve the turn.

The fourth Ufe.

And by the like method an Instrument may be adjusted, to discover whether Tin be more or less adulterated with Lead, since Tin being the lightest of Metals, the Lead will depress the Instrument lower is mixed with Tin, as Gold on the contrary is the heaviest Metal, and is lighter upon the addition of another Metal.

The fifth Use.

It may enable us to guess at the Qualities of Metalline Mixtures, and the proportions of the ingredients, for by adjusting how much such a weight of Gold will depress the Stem, by afterwards trying how much lighter in Water

the same weight of allayed Gold in the Air will be, and at the fame time observing whe was the proportion of Silver in the Alloy, and may be enabled to judge how much other pieces of Gold are alloyed by comparing their weight in Water with this Standard, provided they be of the same specifick weight in the Air. with the Gold unalloyed. And the fame mefores may be taken to make an estimate of the alloys of Silver with Copper, or of Copper with Tin.

CHAP. IX.

Observations of the growth and increase of Metals.

am told by the Master of a Tin Mine, that after a Tin Mine had been quite drained of its Ore, by washing and vanning about 100 years after, it yielded rich Ore again, and that a good quantity of stuff being quite drained of its Ore, and laid on a heap in the Air, in thirty years it afforded Metal again. And the same Gentleman told me, that having caused the Water which walkes the Earth away from the Ore, to lay down that Earth, by stopping the current of it, till its own weight made it fubfide, that Earth being twelve years exposed to the Air, yielded a good quantity of Metal. And Relations agreeable to these I have received from another.

It hath been observed, that Lead Ore cleard of its Metal, and laid in heaps for some years Land fields Metal a fecond time. And J. Gerbard Decade questionum p. m. 22. fays, Feffulamons in Hetruria Florentia civitati imminens, es Plumbarios babet, qui si excidantur brevi imporis spatio novis incrementis instaurantur. d Agricola, speaking of the growth of Mines in general, testifies the same; but I am told, that this happens not in all Mines. And tho' is be believed that the Reason why the passaes into some Mines grow narrower, is to be attributed to the growth of the Metal, yet I m apt to believe, that it may be caused by the powerful expansion of some frozen Water in Earth, that encompasses those passages; and creas it is urged as an Argument of the trowth of Metals, that Lead increases its weight being exposed to the Air on the tops of Carches, yet I am inclined to believe, that it proceeds from a Ceruffe formed by corro-Parts, uniting with the Parts of the corro-Metal, and chiefly for this Reason, viz, me I have observed, that the Wood which about that Lead abounds with an Acid Spicapable of corroding Lead, and that when have been long exposed to this Acid, a te Lead may be scraped off better than the mon Cerusse, and this is found on that side Lead which is next the Wood, and not on exposed to the outward Air. And I have observed, that even Alablaster and white Marble will yield an Acid Spirit, so that we quetion whether Lead fixed to the feet of Statues,

may

may not by the help of that acquire a greater bulk, and increase of weight.

We are told, not only by Pliny and Srabe, but Fallopius and Caffalpinus, that in the Island of Elva not far from the coast of Tuscany, Iron hath been observed to grow; and Agricola attests the like to be observed in Germany. And Foban, Gerberd, tells us; that he was informed. that not far from Amberga, the Ore exposed to the Air for some time in heaps requires Metalline Parts.

I have been told, that Silver grows in the form of Vegetables, and in a Voyage to Pers I find the following relation, viz. That in the Mines of Potofs it is observed, that Earth that was dug out of the Grooves and Shafts, and thrown aside, hath such a propensity to the Production of Metals, that after some years it would yield Metal.

Of the

Tho' there is no Gold to be found on the coult of of Guyny in Congo, and other Parts of Africk where Writers mention it to be found, ye I am told, that in Hungary, the Master of that famous Gold Mine of Cremnitz hath observed that the whole Mountain abounds with Particle of Gold, and that when they have cleared a great deal of the Soil in one Place of its Metalline Parts, they throw it into the hole again, and observe, that in a little time it will yield Gold as before; and Johan. Gerberd. gives us an Instance of the growth of Gold in Germany.

Book V

Poft fcript.

Dr. Brown tells us, that he observed the pasiges in feveral Mines grown up, especially in it places, and that the vellow Soil near

Crimitite yields fome Gold.

Whether the increase of Metals depends on the influence of the Air, or some other cause, all further and more first Observations have ben made, I shall not undertake to determine; but shall only add, that a Marchasite having been that up in Vacuo, it acquired a Vitriolate Eforescence betwixt blue and green.

CHAP. X.

A Hidrostatical way of estimating Ores.

O help me to make an estimate of the proportion of Metalline or the Mineral in- doffaticalnts of Bodies, I weighed a piece of Rock-ly offimated. Critial or white Marble, first in Air and then water, by which I found that its weight, to an equal bulk of Water, was as 2 1 to 1, or as 11 to 4, and then by weighing Metalline Bodies, such as Magnets and Emeri, I found that the weight of these in Water was more than that of Crystal, the proportion of the latter ing as four to one; by which Tryals I was cubled to guess that these stones contain Mefalline Parts in them: And by the same method I discovered Metalline Ingredients in some Bodies

dies which are not generally looked upon as fuch, as Lapis Hematites, and American Talc.

. And as it is generally a certain fign, that a Body contains mineral ingredients proportionably as it is heavier than Crystal, so it is no less certain, that Bodies lighter than Crystal are not impregnated with a Metalline Ore, as Jet, Succinum, Sulphur Vive, common Sulphur, English Talc, Venetian Talc, and black Lead whose weight to Water is but as I 100 to I and which by certain Tryals I have found to be

a kind of Talc.

As for the advantages that may be resped by estimating Ores, they may either respect lewellers, Phylicians, or Chymists, as when the Metalline Ingrediens are but small;or Mineralife whose business it is to extract the Metal, when by this Hydrostatical way it appears to be suffciently impregnated. But, because there are fome cruder Metalline Ingredients in some Bodies, as Antimony, Bismuth, Lapis, Calaminaris and Pyrites, which may deceive an anskilful Mineralist who estimates them this way, it may be convenient to make use of other Tryals to diffinguish them. And fince fome mineral Ores, when tryed in the lump, appear to be poorly stocked with Metalline Parts, it may be of use to beat them to powder, and to separate the Metalline Parts, by washing, or elfe by fire; for by that means I once found, that a Metalline Ore which was wrought for Lead, afforded a sufficient quantity of Silver to answer the charge of working it, and to this caution I must add the following, viz. That fince Marcafites are generally heavier than

common Crystal, and by some looked upon to be plentifully stocked with Metalline Parts. became of their weight, and the glittering of their Parts, yet they may easily be undecived, by placing them in a hot fire, for by that means the Sulphureous Parts will be confumed. and leave behind them a black Calx; but tho' Mercafites abound not with Metalline Parts. proportionable to their bulk, yet I have found by experience, that some of them have afforded not only Copper, Silver, and Gold, but fometimes a quantity of running Mercury; but whether Marcasites may be of use in graduating Gold, or not, I shall leave to others to be considered. There is this Advertisement which I must not omit, and it is that the' fome are and to employ flux powders indiffently without understanding the difference of them, I here tryed, that Lead Ore being fluxed with flings of Mars, afforded a larger quantity of Metal, than with a due proportion of Nitre and Tartar fulminated together; but one part of good native Cinnabar, finely powdered, bemixed with a fix't Alkaly of Tartar, and the other with a different flux powder, we obtaintwice as much Mercury from the former, we did from the latter, tho it was likewise a fixt Alkaly of a mineral Nature. total an order

Some Observations about native Gold.

Tho' I once believed, that there was no such observations as a Gold Mine, in which that Metal was an about predominant, yet I had a Portion of Ore sent me native Gold. from the East-Indies with the spar about it, which

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had I broke it, I question not but that it contained Parts which were malleable without the help of the fire : one piece of this had so much Spar about it, that it weighed to an equal bulk of Water, as 2 to 1. The colour of the Spar was like white Marble tinged with a dash of yellow, and it differed from Lead Ore, in as much as that is usually so foft as to be easily out with a knife, but this was as hard as a flore. and would yield sparks when struck with a piece of Steel; and it differed further from Spar of Lead Ore, in as much as it was altogether incapable of being calcined, tho' kept in a Crucible red hot for fome hours. Nor would it be dissolved in Acid Menstruums, as Sparof Lead Ore may. A piece of Spar in which but littleGold was contained, being weigh'd in Water, was to its proportion as 2 to 1, which is but little above the weight of common Marble.

But tho' there is fuch a thing as true Gold Ore, yet I would not discourage Mineralist from feeking it in Veins of other Minerals, fince it hath been found not only in Copper Mines, but veins of Tin and Lead; for in a place in Scotland feveral grains of native Gold have been found near the Surface of the ground over Lead Mines, some pieces of which being weighed Hydrostatically, one piece of Scatch Gold, which was native and free from adhering Spar, weighed three drachms twenty one grains, and another which had Spar sticking to it, weighed three drachms three grains, and 1 third of Scotch Gold weighed in Air forty



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thre grains, in Water thirty nine. Difference

3 x 1. Proport. 12 x , to one. But to diffingain pure Gold from impure, we are to note,
that the Proportion of the finest, according to
the female, is as eighteen to one of Water, but
according to ours, as nineteen to one. So that
sit comes more or less short of that Standard
me are to estimate its Parity.

And thus by weighing Gold Hydrostatically, we may be able to distinguish, that Sand-Gold which is brought from Africa, or that from Games, from adulterated; for having once weighed a small Parcel of good, the Weight of that will be a Standard to distinguish the bad by.

But since a great many ignorant Sea-men are concern'd in buying Gold, who understand not how to examine it Hydrostatically, I shall subject the following method to distinguish it Chymidly, wit. By mixing a few Grains with Aq. from, Spirit of sermented Urine, or Spirit of line-horn; for if it be adulterated with Copper or Brass, a few Grains laid upon Paper, and seithed with this, will be tinged bluish green. And even rank Urine will be able to extract a like Tincture from Brass, if made use of infections will happen with Sal-Armoniack dissaid in Water.

There are in England such a great variety of scores, that it would be worth while to compare them Hydrostatically, and to compare them with Crystal; for I have found near the high Road an Eagle-Stone, which was not supposed to be of English growth. And I found a kind of Magnesia near a Potter's Work-house,

which

which he afterwards made use of to glaze his Pots. And I was brought to a Mineral Subflance. which tho' it was hard to be known of what Rind it was, yet I foon discover'd it to abound with Vitriol, and that it would yield it much more plentifully than the Vitriol-Stones found near the lile of Wight, or those made use of at the Vitriol-Works near Depuford, and elsewhere. And Ore of Bismuth hath been discovered by a heedful Eye, when common Miners knew not what kind of Substance it was when they dog

it up.

which

But this Hydrostatical way of estimating Ores may not only be made of use in judging of Mineral Substances, but those Earths which are the Wombs of them; fince, tho' they cannot be fuspended by a Hair, as folid Grains of Ore, vet a lar may be counterpoised in Water, and then being filled with such Earths, the weight of them may be discover'd, by first counterpoifing them in the Air, and then having first wetted them with Water, and convey'd them into the Water in that Hydrostatical Bucket: And that this Hydrostatical way of weighing Earths may be of use appears, fince it hath not only been observ'd, that a red Mud, which lay at the bottom of Water, abounded with Iron plentifully, but I have observ'd the same in an English Oker. And I have been told, that Diamonds, as well as Gold, have been found in a red kind of Soyl. And I have observ'd in Be pland, curiously figur'd Crystals lodged in a Soyl of a red Colour. STRUCTURED BY SE OF DODGE

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And it may not only be of use to weigh difores of Earths in our Bucket, but also seme difcern'd several Grains to appear, as if I have experienc'd, not only Hydrostatically, that that black Sand which is made ofe of Landon, contains good store of Particles of Martial Nature; but I have likewise been convinced by fluxing it, and by cafting it, whilft is was melted, into the Conical Part of a Cruoble. And I further observ'd, that i of it rould be attracted by a powerful Load-Stone. Bot a Mineral of a martial Nature hath not been observ'd in Sand, but Gold on the of Guiny, and on the Banks of Tagus ich runs by Lisbon and Paliolus; and fome been found on the Banks of the Rbine, and little River which runs down from the Mountains in Savoy. But much more Gold may be from Sand Chymically, than by picking it If the Sand be reduced to Glass with Ligeor Minium, and then the volatil Gold cottain'd by giving it a Body fit to retain and to the fuch as Silver, out of which I have got Quartation, out of as much vitrify'd Sand as al a Retort, and two or three fluxing Addisints of fmall price, fixteen grains of pure Gold. And tho' by fome it is thought strange, that there should be a necessity of fixing Gold, yet I have elsewhere made it appear, that by a imal addition of another Substance, Gold may be fublimed without a naked Fire, and form feveral Crystals like Rubies.

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And if Sands, as well as Earths and Stones, abound with Mineral Ingredients, it may be convenient to take an account where fuch Subfrances are found, and likewife to take a Sample of them, as also of the Ores of different Mines. and to try them Hydroftatically; for I have obferv'd, that in English Lead Ores of several kinds, those in which thirty pound of Lesd is only to be got out of an hundred of Ore, are looked upon as not worth working; those that yield half their weight of Metal are indifferent; and other Ore which yields from fifty five to firty in the hundred is looked upon to be very good; but those that afford eighty Pound in the Impdred, are accounted very rich; but I have not met with any that afforded more than feventy five in a hundred weight: Which Ore feemed to confift wholly of Metal, and was made up of Parts of a Cubical Figure, and much refembling Dies placed one by another.

But besides what hath been already proposed, to be inquired after concerning Metalline Fossils, not only its Proportion is to be considered, but the plenty or scarceness of the Mineral, the easiness or difficulty of coming at it, as also its depth and freeness from Waters, its meaness to plenty of Fuel, its nearness to Water to drive Mills, and to transport it, the are to be considered likewise before one begins to works Mine.

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As Explication of the Infruments employed in the Experiments, and those in the following

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(a) The Beam, (bi) the Dishes, (c) the Frame Su Plate 1, to injund the Beam, upon which (d) a sliding Fig. 00.

Societ. (e) its Arms containing (f): a Pulley, one which (g) another Pulley passes, (b) a Line falsed to (f) a moveable Weight, by which he Beam is raised up or let down, (k) a Hair to superior (l) the Body to be weighed in the limits, held in (a) the Glass Ciftern, (n) the latest for Liquots, (e) the Box of grains, (p) the Forcepa to manage them, (q) the Pile of liquots, (n) the Handle of the Ballance, (arm) the Table.

Medicina Hydrostatica.

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ROM what is contain'd in the fore-going Chapter, it appearing that white Marble a Capital may be a Standard to diffinguish mineral Substances from other Bodies, I shall be subjoin the way of weighing finking Bodies it Water, 1991

Add first, the folid Body to be examin'd, is The method to be suspended by a Horse-hair, at one of the of weighing scales just now described, and there to be comperposed; then the Weights being taken out, by deducing from the weight of the Body in Airthe weight of it in Water, by the Remainder divide

divide the whole weight of the given Body in the Air, and the Quotient will shew the Proportion in specifick Gravity, betwixt the examin'd Solid, and as much Water as is just equal to it in Bulk. For Example, if the Weight of a Co. bick Inch of Rock-Crystal be 1169 grains in the Air, and 738 in Water, the Remainder will be 421 grains; by which the 1160 grains being divided, the Quotient will be found to be 2 x 2 or near enough & for the proportion of the Gravity of white Marbles to Water.

In which Direction it is requifite to observe Continu first. That what we have faid implys, that the quifte " Body weighed must be heavier than Water, Se condly, Horse-Hairs are more convenient the other firings, because they are nearer to a specifick Gravity with Water, Thirdly, Where the Figure of a Body disabled us from suspending it by tying a hair about it, we platted a fort of net of Hairs to hold it in. Fourthly, So much of the Hair as is above the Water must be counterpoised by a Weight in the other Scale. Fifthly, Sometimes instead of the Scale I counterpoifed the opposite with a weight of Lead, and fulpended the Horse-Hair at the String; box when I did not take off the Scale, I caused it to be perforated in the middle. Sixthly, Care must be taken that the Water below touches not the bottom of the Scale, and that the Body be freely fuspended, and wholly immersed in the Water. Seventhly, Care must be taken, that no Bubbles of Air be contained in the Pores of the Body weighed, fince the fuccess will be apt to fail in some Tryals upon that account bak we were of it in Wester by the Memainder



mftances being observed, it will b know, by the method proposed, the betwire the specifick weight of other eavier than Water. It being agreeable Hydroftatical Paradox of Archimedes Body, heavier than Water, weighs less hter than in the Air, by the weight of as Vater as is equal to it in Bulk or Mag-Andau of 2, and an ore

this Method we found, That the weight The Honatites to Water, was as four 15 to Ufe of by fulliming it with Sal-Armoniack, peighing d by the Aftringency of it, that it a- Ba with Metalline Parts of a Martial Nawhich was further confirmed, by obserat a grain of it turned an Infusion of Galls ofis Lazali was to its bulk of Water in three to one. A Load-Stone, which agnetical, bath Medicinal Vertues, apto be as four 2 to one. Lapis Calamimans four to one. In which Concretes, ledicinal Virtues feem to depend on the sife mixture of metalline Ingredients; but Bodies which abound less with Mineral inces, may be as operative, by reason of more active Particles. But,

The Hydrostatical method of weighing Bo- use it may be further ferviceable in diftinguish-Stones from Plants, or other petrified Subfaces, as Coral, which weighs in proportion to Water, as two & to one, and therefore appears to be a Stone, being heavier than Cry-A monstrous Pearl taken out of an Oyster, which weighed 206 grains, was to Water as to one. A Calculus Humanus, which cile

weighed

weighed fix drams and a half, was in proportion to Water as one Z to one; and another that weighed four drachins and a half, was to Water as one to one. Thefe Stones, tho' the preductions of Diftembers, have been accounted hetter than Oriental Bezon in their Effects Choice Bezoar Stones, which weighed three drachms in the Air, being weighed in Water, one of them was as one to one; another fomewhat lighter, was as one & to one; as third, which was taken out of another Stone which being weighed in the Air weighed fr drachms wanting nine grains, was in proportion to Water as one " to one . So that thefe have a much less specifick Gravity than Foli Stonesso acidente carbonanti lo atarne intigan

Ufe III.

A third wie of this Hydroftatical way of weighing Bodies, may be to diftinguish several Species of Bodies into Subordinate Species, the Load stones of feveral Countries are different in weight; for I have observed Norwegian and the English Load-stones, to be heavier in frecie, than those that came out of Italy, in which the Island of Elba abounds with Mines, whereof one intire Mais weighed a great many hundreds

Ufo W. Fourthly, This method may enable be to diflinguish counterfeit Stones, from those that are real and good, fince when they are Hydroflatically weighed, there will appear a manifest difference, not only in adulterated Coral, but Be-

zoar, and other valuable Stones, de and of the

Fifthly, By this means we may be enabled to Use P. distinguish betwixt genuine Concretes used in Medicine, and those that are not genuine; Lougiow

alfo



ther precious Stones abound more or with Metalline Ingredients. But the' fomeentifully impregnated with Medicinal and Effluoia, yet confidering the Activity ad great fubtlety of fome Pigments, the latter be as powerful. And that every fensible at of a Body may be impregnated by a small mity of Pigment, will appear from the folering Experiment, viz. If five grains of Zafinely powdered; and kept in fusion in a with a violent hot fire, it will give the eafine blue colour, and if the proportion the Zaphora be as one to fix, the Glass will to deeply tinged to make a handsome Gem. And to thew further, that a finall quantity of Metalline matter may be sufficient to impart wirtne to Glass and even Gems, I shall add, that eight grains of the powder of a German Granate, being kept in fulion with an ounce of Cryfalline Glafs, it gave it a Tincture like t which Steel gives to pure Glass.

the proportion of folid substances to Water may be Hydrostatically distinguished; but since there are other substances which cannot be so weight, being either subject to dissolve in Water, as not fit to be suspended by a Hair, by reason of their form, being either powders or liquids, to make an estimate of these, I contrived the Bucket formerly mentioned, and represented in Fig. 00, Plate the first, which being suspended in Water and counterpoised, we put a known weight of Quick-silver in it, by which means

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comparing its weight in Water with its weight in Air, and dividing the greater number by the difference of its weight in Air from what it was in Water, and which was thirty four grains, we found the Quotient to be fourteen and about ,, , fo that the Mercury made ufe of in this Tryal was as 4 10 to 1, but common Mercury which is fold in the Shops we have found to weigh not above thirteen and a half to one, and indeed I have found a notable dif parity in the weight of most common Mercuries especially those drawn from Gold; for the Mercury being combined with that Mctal become heavier than common Mercury. By the fame measure we may know the specifick Gravity of any Liquors which are heavier than Water, and which are unapt to mix with it, fuch a Oyl of Cinamon, Cloves, Guajacum, &c.

And by the affiftance of the same Bucket, in may be able likewise to weigh Powders, and estimate their goodness, if we put a known weight of them in the Air into the Bucket, and pour in gently as much Water as will fill upthe Pores contained betwixt them, and be fufficient to expel the Particles of Air contained betwixt the small Parts of it; but in all thek Tryals it will be requifite to fufpend the Scales of the Gibbet delineated in the preceding Figure, that the Scale may hang the steddier,

whilst the Body is a weighing.

But fince there are feveral faline Bodies, # Sublimate, Mercurius dulcis, Vitriol, Rock-Allom, &c. which cannot be weighed in Water, in such cases, instead of Water, we may substitute Oyl of Turpentine, which tho' it be

different specifick Gravity from Water, by carefully weighing a parcel of any fubce which is genuine in that Liquor, it may re for a Standard to estimate the goodness fother parcels of the fame fubstance by, and will be no very difficult matter for one well billed in numbers, by comparing the specifick Gravity of Oyl of Turpentine and Water tother, to know what proportion the Body thed in Oyl, would bear to an equal bulk of mon Water.

other way which may be taken to estimate frecifick Gravities of Liquors is, by makuse of a Body that will subside in all Liquors Quickfilver, for thus by first weighing that dy in Air, and then in feveral Liquors, and ring noted the difference betwixt the folid each of the Liquors, it is not difficult to the specifick weight of each, and the proactions betwixt them. And fince it is but one d that is compared thus to the differing Liwhatsoever their Number is, it will not difficult to compare the specifick Gravities the Liquors betwixt themselves, and to disthe by the weight of the first, that of any which ever one pleases.

But in making choice of fuch a folid Body, ferve our present purpose, care must be that it be fuch as will not be subject to confirmed by Effluvin; or too large for a tender Ballance; nor fo big as to require too much Liquor to cover it; and lastly, it ought to be of such a Nature, that it may not be liable to be corroded by sharp and corrosive Liquors, eafily broke, but such as may be easily oh-

tained.

tained, that what Experiments are tryed with it may eafily be tryed by others, and communi-

cated to Posterity.

The Bodies made use of in trying these kind of Experiments, and which came nearest what we thought requisite for such Tryals was when we examined common Water, Rain-Water, Spirit of Wine, Wine, Brandy, Vinegar, and the Liquors drawn from it, Cyder, Beer, Ak. Urine, Waters distilled from Vegetable and A. nimal fubftances; Amber : But to estimate the weight of heavier Liquors, we employed a Glass-Bubble, Hermetically sealed and filed with Mercury. But this being both hard to be obtained, and harder to be preserved, I made use of the following Body in such Experiment as are to be recorded for Posterity, viz. Globe of Rock-Crystal which was suspended by a hair which passed through a small hole in it and which we employed to discover the d rence of those Liquors, which we could obta greater quantities of, but for others we employed an Hexagonal Prism, with a kind of Pyrimid at the end, and this Body being of fuch a Figure we were able to employ it in small Gylinders, in which a small quantity of Lique would furround it and cover it. The weight of the Ball of Crystal we employed was to is bulk of Water as 2 17 to 1, and the weight of the Prilm as 2 1 to 1.

And this method of weighing Amber in different Liquors, may not only acquaint us with their specifick Gravities, but also from theme we may learn to know which are most Spirits-



For tho' a piece of Amber weighed but 6! grains in Water, yet in common red French Wine it weighed 8; in Nants Brandy 17; and

in rectifyed Spirit of Wine 34 1.

This Hydrostatical method of estimating may hewife contribute to discover the strength of Add Liquors, those that are strongest causing the folid to weigh less, as they are stronger, the greater decrement of weight proceeding from the greater proportion it contains of Sala that are not Volatile. It may likewise fave the wasting of several Liquors, as Spirit of Wine or Brandy, in trying their goodness. And further it may be imployed in estimating the intensive weight of Wine, Beer, Ale, Mead, Coder, oc. and diftinguish their goodness, hout confuming them.

Amber will not be heavy enough to diin the strength of Oyl of Tartar per deliand fuch heavy Bodies, fince they are

ty for it to fublide in.

fides, the afore-mentioned there may be er use made of our Hydrostatical solid, To shew when Menstruums are of a concan frength. For that there is a peculiar of Spirituousness requisite in some Solfrom is evident, fince if Aqua Fortis be too from it will not be able to dissolve Silver, no more than if it be too weak, till it is diluted by an dition of Water; and it is much more fit to folie filings of crude Lead, when more dilute : So rectifyed Spirit of Wine is not always the of proper Menstruum for gummy Bodies, at diffolves only the pureft Refin, and the Mucilaginous Parts behind, which may

may be as good in Medicine as the other, and further we fee that Gum Arabick and Tragacanth are not so easily dissolved in good Spirit of Wine as in weak Liquors; and the like may be observed

in dissolving Myrrh.

To what hath been faid on this occasion, there is one thing to be added, that when this Expedient is made use of in Oyl of Vitriol or Tartar per deliquium, it is necessary to put something into the Scale to compensate the lightness of the Horse-hairs, since in such Experiments the specifick Gravity of the Liquors exceed the Gravity of the Hairs, and consequently they will be apt to buoy up the Body immersed, and missinform us in its true specific weight.

To the afore-mentioned ways of Hydrostaically estimating Liquors, we may add the following. And first, it may be done by silling a Vessel with a stender Stem successively, with different Liquors, and weighing them, as also it may be done by a Brass Cylinder, made heavier at one end than the other, by which it may be made to float, and to swim deeper or higher above the Water, as the Liquor contained is heavier; or another way is by sitting too Bubbles together with Cement, by which their Stems being joined, and the one caused to such lowest by a Ballast of Mercury, as the other is filled with a heavier or lighter Liquor, it will manifestly preponderate.

Another way proposed by Mersennus, is by weighing a Glass and a Stopple in Water, and then filling the Bottle quite full, and putting in the Stopple; for the weight of the Glass and

Stopple

cople being deducted from the weight of the shole, the remaining weight will be the weight of the Liquor proposed. But instead of this we made use of a round Glass-Ball with a Glass Stopple, which being first weighed in Air and Water, and counterpoised there, we were able to discover the weight of the Liquor contimed, and its proportion to the bulk of the Liquor it was weighed in; and if the Bubble were too light to subside in some heavy Liquors, we would bring it to a just weight by a Ballast of Mercury. But fince fuch Vessels as these me very hard to be got, and some other inconveniencies attend it, we think it less satisfactory than those other ways we made use of and proposed before.

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A fixth Use that may be made of these Hytrical Tryals, is in reference to feveral Medad Bodies, for thus the Jucies of Plants may weighed, if when they are contained in our pholatical Jar, delineated in the Figure athey be hung at a nice Ballance in Oyl, d of Water, fince they are not subject to with it: And by this means we may be fatiswhether Juices of Plants alter their specifick wity, when kept a good while, and after ferextion. And by this method likewise we be able to weigh Honey, Vinegar, Ver-Cc. As also we may compare and weigh luces of Fruits of different kinds, and the ordinate Species of each kind, as also the seratal nices in their several states of Crudity Maturity; But the use of this Hydrostatical chet being very tedious and difficult, to dole that are not very skilful in making Ex-

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periments,

Use PL

periments, the other will be more useful which

are tryed with Amber.

But to what hath been already delivered on this subject I shall add, that the in several Tryals made with precious substances, a nice Ballance is requisite, yet in most cases the difference betwixt Bodies is great enough to be discerned by a Ballance, not altogether so nice; for let the Ballance be never so nice, there is difference in the Textures and Compositions of Bodies of the same Denomination, for which, as well as in defect of a nice Ballance, allowances are easily made.

But perhaps it may be objected by some, a gainst the method I have been proposing, that since I generally weigh most Bodies in Water, it will be a hard matter to make them with any exactness, since it hath been observed, that most Waters themselves differ in specifick Gravity. But to this I shall briefly answer, that I have not perceived so considerables difference as will frustrate these Experiments, in which we require not a Mathematical, but a

Physical certainty,

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CHAP. XII.

Hydrostatical Stereometry applyed to the Materia Medica.

T being usual for Physicians in the descriptions of feveral Parts of the Materia Medica, to fignifie the fize of Bodies by very indetermimite Terms, I thought that they might be fifted by Hydrostaticks, to give descriptions much more exact and fatisfactory; and for that end having made two hollow Brass Cubes, whole Cavities, being Cubical Inches, contained 256 grains, or a Cubical Inch of Water, it being Law in Hydrostaticks, that whatever Body is weighed in Water, it loses so much of its weight, as an equal bulk of Water weighs, I concluded it would thence follow, that whaterer folid was weighed in Water, if in that flude loft 255 grains of its weight, it might be faid to be a Cubical Inch; and as it lost more or les, so it might be said to be of a Magnitude proportionable; for if it weighed but 128 grains less in Water, it might be faid, to be of fuch a bolk as answers in Magnitude to half a Cubick Inch of Water; but if it weighed 255 wanting thirty two grains, that being an eight of a whole Cubick Inch of Water, the bulk of the body may be faid to be ? of a Cubick Inch. And if the Body weighs one ounce thirty two grains (amounting to 512 grains) or one ounce and a half forty eight grains (amounting to 768 grains) the bulk of the Body will be equal to two or three Cubical Inches. And if after

after the Division there remains a Fraction, it will not be difficult to estimate it, and to know the exact bulk of the Body, fince the Cubical Inch confifts of fuch aliquot Parts, as are easily

and regularly divided and subdivided.

And thus we may easily know the bulk of a Body that is heavier than Water, but if it be specifically lighter it will be a difficult matter. The method Mersennus proposes is this, viz. First, weigh the Body to be examined in the Air. Secondly, take a piece of Lead of a determinate weight, and able to fink the other Body in Water. Thirdly, weigh the Plate in Water, and the weight it loses in Water, will be the weight of Water equal in bulk to the Body weighed. Fourthly, tye together the Plate of Lead and the lighter Body, and note the weight of the Aggregate. Fifthly, weigh the Aggregate in Water, and substract the weight of it there, from its weight in the Air, and the difference will be the specifick weight of the faid Body in Water. Sixthly, from this difference, fubstract the formerly found specifick Gravity of the Plate alone in Water, and the remains will give you the weight of the lighter Body in the fame Liquor. And then dividing the obtained weight of the light Body in Water by 256 grains, and it will give you the folid content of that naturally floating Body. To illustrate this method, I shall subjoin the following Experiment.

I. The Oaken Cube in Air weighs feven? drachms, thirteen grains and a half.

11. The weight of the Lead in Air, four? drachms.

III. The



(three drachms and a half, ten grains) which being substracted from its weight in Air, leaves for its specifick weight in Water.	
IV. The Aggregate of the two in Air is 43 V. The weight of both together in Water is	3:
which being substracted from its weight in Air, gives the difference of both the Aggregates.	
VI. The difference betwixt the weight of Lead alone in Air, and in Water, or which is all one, the specifick weight of the Plate alone, viz.	
Being substracted from the difference of the Aggregates in Air and in Water, gives for the weight of the Cube proposed- which wants but four and a half of the	1.
weight of a Cubical Inch of Water.	

The same method that hath been taken with solids not subject to dissolve in Water, may be taken with Alloms, &c. Which is only by employing Oyl of Turpentine instead of Water; for a Cubical Inch of that weighing 221 grains and 1, the difference of the weight of a solid in the Air, and in that Oyl, being divided by that Number, the Quotient will give you the solid contents of the Examined Body.

But to discover the weight of Bodies, which are apt to imbibe too much of the Liquor they are weighed in, we may guard them from it by a thin coat of Bees-Wax, and having first

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ullion.

taken the weight of the Wax in Air, and then fallned it to a Plate of Lead, Substract the weight of as much Water as is equal in bulk to the Wax.and proceed with the Body contained, and the Plate of Lead as before taught; and having thus obtained the Weight of the proposed Body in Water. by dividing it by 256 grains, by the help of the Quotient we may obtain the folid contents of the proposed Body. Another way I devised for to learn the folid contents of a Body, without imbibing Water into it, was, by finding the weight of a Cubick Inch of Mercury, and also the specifick weight of the Vessel, and then pouring upon the Body contained in that Veffel as much Silver as it would hold, by knowing the weight of that Quick-filver from the weight of the whole which the Vessel would contain, one might be acquainted, to how much Mercury the matter contained was equal.

Having thus proposed a Hydrostatical way of trying Bodies, I shall leave it to others to contrive an Instrument more apt for such uses than I have done: And shall to what I have said add, that these kind of Experiments do not always equally answer in success, being apt to be diversifyed, as well by the want of uniformity in the Qualities, and specifick weight of Bodies of the same Denomination, as by the difference in Water in intenfely Hot and Cold Weather; as also upon the account of less exact Ballances. But another reason is the difference of weights of the same Denomination for we are told by a diligent Mathematician, that, cum omnia grana, vel semina, que reperiri solent in atriis venalibu Lutetie, and ftateram expendisset, vix gramm



inter ejustem Speciei grana grano alteri exde respondisset, in incertis Ludere noluit. And in fame Author tells us, that 688 Roman grains re but equal to \$76 French grains, and this chimate of their difference by another Ballance res found to be thirty fix grains falle : And the fine Author receiving two accounts of the number of grains contained in a Roman onnce, the one told him there were 612, the other 576. And tho' our weights as well as those made use of by Gberaldus, have twenty four scruples in an ounce, yet he divided his scruples into twenty four grains, whereas we divide ours but into twenty. And Mersennus, p. 37. lib. 16. tells that cum autem dixi Chelinum, undecim dici denariorum, credunt tamen alii decem duntaxat, nil affero. And.

To what hath been said, I shall only add, that the this method of weighing Bodies be not Mathematically exact, yet it comes as near Physical exactness as we can expect, and may be of use till some more nice way of Tryals be sound

out.

A Table representing not only the Weight of several Bodies in Air and Water, but their Proportions in Weight to an equal Bulk of Water.

A	Weigh In Air	the is	Dratamin.
	in Gr.	Grains	
A Mber —	306	12	I to I.
A piece of Allom-	251	156	2 401.
Stone - good and	280;	152	2 10 to 1,
Supposed to be Hungarian One-	391	295	4 7 to 1,
В			
Bezoar stone	18-	6.	1 # to 1.
Bezoar stone A piece of the same	56;		1 401.
A fine Oriental one_	172	60	I noto I.
Another	237	61	
C			
Coral red	129	80:	2 63 to 1.
I'multal	256		2 100 to 1.



. In Air	ter in	Proportion.
		3 0 to 1.
94004515005		1 100 to 1.
331	85	In to I.
77:	36:	1 100 to 1.
90;	54	2 to 1.
138	123	8 pt to 1.
	49:	43 to 1.
802	702	8 to I.
197	169	73 to 1.
197	171	750 to 1.
336	204	2 1002 to1.
139	85	2 17 to 1.
302	97	1,47 to 1.
1436	1090	4版to 1.
413	314	41 to 1.
226	194	7 to 1.
	148 2570 331 77! 90! 138! 65! 802 197 197 336 139 302 1436 413	In Air ser in in Gr. Grains. 148 103 2570 1080 331 85 77: 36: 90: 54 138: 123 65: 49: 802 702 197 169 197 171 336 204 139 85 302 97 1436 1090 413 314

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ir

ns of

Gold Ore not Rich,
brought from the
East Indies— 1100 682 263 to 1.

Another Lump of
the same— 1151 717 265 to 1.

Granati Minera— 217 147 3 10 to 1.

Granate Bohemian— 4166 to 1.

Hema-

H Hamatites English	in Gr.	ter in Grains.	
I			in the
Ivory	1732	83	1 % to 1.
L			1
Lapis Manati A Fragment of the	450	293	2 to 1.
Same	218;	123	239 to 1.
Another from Ja-	345	197	2 noto1.
maica	2011	1127	2 m to 1.
piece	385	256	2 to 1.
Lead Ore	686	590	710 to 1.
Lapis Calaminaris -	477	380	4º to 1.
Lapis Judaicus	261:	164	2 to 1.
M	1	bi.	e vid
Marcasites	814	631	4 to 1.
bridge	243	189	
Wa.			Another



THE RESERVE THE PROPERTY OF THE PARTY OF THE		STATE OF THE PARTY		,
Another more Shi-	In Air	In Wa- ter in Grains.	Proportion.	
ning than ordi- nary reviv'd	287	227	4 ½ to 1.	
from Ore- Manganese a piece- Mineral Cornist, like a shining Marca-	321	230	3.0 to r.	
file —	145	129	9 to 1.	
Ofeocolla	195	108	2 to 1.	
from Saxony—	458	366 960	4 [∞] / _{1∞} to 1. 7 to 1.	
OreLead from Cum- berland Rich —	1872	15863	to 1.	
Rhinoceros born- Rock-Chrystal, ano-	8563	4260	1,20 to 1.	
ther Piece	256	140	2 100 to 1.	
CHEST STATE OF THE PARTY OF THE	and the same of			

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Sephir____

	,		- NO.
Seed-Pearl	In Air	In Wa- ter in Grains.	Properties.
Sulphur vive—	371	185	2 to 1.
Germane very fine-		152	1 0 to 1.
Slate Irifb-	779		2 to 1.
T			
A Piece of Tale like			1.11
Lapis Amian-			
thus-	596	334	2 to 1.
thus————————————————————————————————————	802	508	2 71 to 1.
Tales .	-0	0	
C Jamascan —	1057	1230	3 to 1.
Iven English I in			
Ore, Mr. Huberts.	812		4 to 1.
Tin Ore black Rich.	1293	984 .	4100 to 1.
Another pieceChoice.			5 to 1.
Tutty a piece-	104	83	5 to 1.
Tin-glass	468	419	3 to 1.
V			
Vitrum Antimonii	12 74 600	A. A. A. A.	
per se	257	2821	42 to 1.
Vitriol Engl. a very	37/1		7.00
per se- Vitriol Engl. a very fine piece- Unicorns born a	1002	512	1 to 1
Unicorns born a	75		100
piece	407	100	1 % to 1.
	40/	-4)	THE



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WORKS

Of the HONOURABLE

ROBERT BOTLE, Efq;

EPITOMIZED.

BOOK V. PART II.

CHAP. I.

An account of a strangely Self-moving Liquor communicated in the Transactions of November 26. 1685.

N Ingenious Mathematician having mix- of a selfed feveral Ingredients in an Earthen moving Li-Pot over Coals, the matter took fire, quer. and began to blaze furiously; which obliged him to stiffle the flame, and remove it from the fire; and when it was cold, he several times successively and at some distance of time observed, that the Liquor moved variously and briskly:

briskly; and some seeds being thrown upon it, they formed a fort of scum; part of which being removed, and the Liquor placed in a warm Laboratory, I observed the following Phane-

mena.

1. The four which remained on it being broke, part would be carryed to the left hand and part to the right, by the motion of the Liquor. 2. When it came from under the fcum, it moved very briskly, as if its motion upwards had been checked by it. 3. The U. quor confifting partly of Oyl, and partly of Bituminous Ingredients, their motion might not only be the better difcerned, but fomed those Oyly Parts rising up to the top of the Liquor would diffuse themselves orbicularly, and form a great Halo adorned with the vivid colours of a Rain-Bow, and these would continue till they lost themselves successively under the 4. The motions of this Liquor were frequently Vortical, which appeared by the motion of some Parts of the scum. And the Liquor all this while was actually Cold. s. Some of this Liquor being poured into a Cylindrical Glas, it moved not as before, but being poured into a shallow wide-mouth'd Glass, it moved more briskly and variously than before in the Earthen Veffel. 6. It moves more briskly or flow # the Weather varies in temper, and in all hath continued its motion ten days; and it continued this motion when poured out of a Vial into convenient Glass seven or eight weeks after, but very languidly, and foon began to flacken its motion in point of swiftness; and from the first to the last time this Liquor was observed to move, it was about five Months.





CHAP. II.

Of the preserving of Birds, and other small Fætus's.

There's, I preserved Chickens taken out of ving Birds, the Shell at several times, and on several days for Incubation, by keeping them in Spirit of Wine to which I sometimes added Spirit of St. Amoniack prepared with Quick-lime, and that the Liquor might not be discoloured, I study remove them twice into fresh Spirits, before I design to preserve them in it.

CHAP. III.

A Conjecture concerning the the Bladders, of Air found in Fishes. Communicated in the Transactions of May 25. 1675.

To shew whether a Fish moves in the Bladders of Water, by expanding or by a constriction Fisher. of himself, and whether the Bladder within him be contracted and expanded according to the several depths he swims at, we contrived the solution following Experiment, viz. To put several Fishes into a Bolt-head, filled with Water, and whose Stem is drawn out very fine, and sealed up when filled with Water; for if when the Fish sinks, the Water in the small Tube subsides, we may conclude he contracts

himself; and if when he rises, the Water rises alfo, we may conclude that he expands himself.

CHAP. IV.

Laudanum Helmontii Junioris: Communicated in the Philosophical Transactions of October 1674.

Preparations of Laudanum. T AK E of Opium four ounces, of the Juice of Quinces four pound, cut the Opius small, and digest it in the Juice of Quinces to days or more, then filtre it, and having infeed in it, of Cinnamon, Nutmegs, and Clove each one ounce, let them infuse six days, and then having let it just boil a little, filtre it, and evaporate the moisture till the Mass is of what consistence you desire, and incorporate with it two or three ounces of Saffron well powdered, and make it up into a Mass. The Dose of this Landanum, if kept liquid, is from five to ten drops or less; and of the Pills a less quantity is required.

CHAP.



CHAP. V.

Observations of an Earth Quake made at Oxford, and communeated in the Transattions of April 2. 1666. paned, and large Chains made in it by the

Iding betwixt Oxford, and a Lodging in Observation the Country, which was four Miles off; Farth the first two Miles it was colder than at o- Quate. ther times all that Winter, but before I got home the Wind turned and Rain began to And in an hour after I perceived a bling in the House where I was, and soon after there happened a brisk Storm. At hal, a place higher than where I was, the Enth-Quake was more sensible, the Stones in the floor of a Gentleman's House being perceived to move : This Hill abounds with fereral kinds of Mineral Substances; and I am that from that place the Earth-Quake exmoded it felf feveral Miles.

CHAP. VI.

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Passages relating to the Art of Medicine.

THO the following passages may be of imall nie to the Ingenious, and Experiaced Masters, yet since they may be servicable the Art of o younger Physicians, I shall for their Infor- Medicinet. ution impart them, the sel of the state

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EXPERIMENT L

A tail well fet Gentleman about twenty four years old, having by a fall broke his Skull in feveral places, which were feveral times Trepaned, and large Chaims made in it by the taking away of feveral pieces, in about three days time he was feized with a Palfey on one fide, so violently as to be deprived of motion and almost of fense, except that in his La he had some short remissions. And this Pale continued about twenty four weeks, about which time his head being further laid open the found a Splinter of a bone much like the feel of a Fifth, which fluck so fast and close to the Dura Mater, that an effusion of Blood accompanyed the taking of it away, but that being stopped in about three days time his Palie began to leave him, and he is now very from and healthy, tho the Callus which supplies the place of his Skull be very large. From whence it appears, what great effects may spring from a very slight cause. But, besides the aforementioned Observations it was further to be taken notice of, that the Parts whilst the Palsie continued were not only deprived of fense and motion, but were very much extentated by a continued Atrophy, which loss of substance they acquired again upon a Cessatton of the Paralytick affection. And it was further to be observed, that all the difference betwist those and other Parts was, that they were more subject to be cold. To which we may add, that tho' he was frequently let blood,



he continued to have a good fromach; nor did the affection of the Brain cause the least Voniting or Convultions.

EXPERIMENT II.

To shew the great and terrible effects of fidden Passions of the mind, I shall relate the following History, viz. That a Woman having taken a Boy to a River fide with her, which he loved very well, the Boy accidentally falling nto the Water unseen by her, when she misled him the was taken with a dead Palife, which could not be removed.

EXPERIMENT III.

But to shew what contrary effects violent fallow of the mind may have, I shall add, that a Gentleman who was in his youth taken it fo violent a Sciatica, that he could not so, but was carried to Church, and look't upon as Incurable; yet once, when he was in the Church, news being brought that the theny was entred into the Town, (which Frontier Garrison,) and designed to Masacre all in the Church, they all fled and left behind them, who being as much afraid of infelf as the reft, got off his feat, and walk'd along other Men, and this I received from the befor affected forty years after the faid fright, the in all that time suffered not the least reof the Distemper.

It might be of no finall advantage to Phylick, would Philosophers, amongst those Experiments

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ments which they lay down, as relating to what they write purposely about, communicate those which they think of use to Physicians, though they should be less pertinent to the Subject under Consideration; for which reason, I shall for the future communicate fuch, desiring this short Advertisement may be my Apology.

A defined Chymical Medicine,

EXPERIMENT IV

Though Vomitive Medicines are not a little dangerous, yet fince in feveral Difeafes they are altogether requifite, I shall here lay down a Preparation which is as effectual, and yet fafer than any other Liquor, and much to be preferred before an Infulion of Crocus Metallorum.

The Preparation is this, Distill two parts of Antimony, and three of Spirit of Wine, in a Glass-Receiver, 'till the distill'd Menstruum is succeeded with red Flores, and filtrating the Liquor through Cap-Paper, lay it up for use close stoped. It may be given from four to eight or ten Drops, in a spoonful or two of Wine, Black-Cherry Water, or Spring-Water, drinking some of the same Liquor after it, to wash it down; it works very soon, and evacuates plentifully and effectually without danger. It hath had not only very good fuccess in Surfeits and several other Cases, but cured a Perfon of an intermitting Feaver, which put on various Types, and continued to afflict the Patient three Years, notwithstanding great quantities of the Jesnit's Powder had been frequently given.

given. But here it is requisite to add this short Advertisement, viz. That the Powder, if kept long, being apt to precipitate, it must either be made use of whilst the Liquor is fresh, or the Bottle must be shaked well when it is used.

A designed Chymical Medicine.

Considering the great esteem and value of Mineral Waters, I contrived a way to imitate them, by making use of Ingredients, very harmless in themselves, and likely to make no less

innocent a Composition.

The Tryal was this, Having digested in a Bolt-head, two days, one part of Filings of I-ron, with ten of distill'd Vinegar, and then increased the Heat'till the transparent Liquor appear'd to be of an Orange Colour, we poured part of it off, lest the Menstruum being too much impregnated, the Metal should be precipitated. This Orange-Colour Tincture being tept for use, we dropped four Drops into eight Ounces and a half of common Water, which made an artificial Spaw, whose Taste not only agrees with that of the Natural Spaws, but it will, like Tunbridge or the German Spaw, turn a Tincture of Gauls Purple.

EXPERIMENT V.

The Becoar Stone being a Medicine of great use, not only in malignant Feavers, but the Plague; and by reason of its dearness apt to be counterfeited, I shall add the following way of Aa 4

distinguishing betwixt good and bad, viz. by disgesting about fifty grains finely powdered, with six drachms of Spirit of Nitre, in a digestive Furnace; for after they have been mixed some time, the Spirit begins to dissolve the Powder, and extracts a red Tincture; which being placed in a North-ward Window about eight and forty Hours, shoots into Chrystals, much like those of Salt-Petre.

To shew that the purging or astringent Qualities of Bodies, depend on the Disposition of the Patient as well as of the Agent, I shall intimate, that a certain Lady having eat a Toast with Cinnamon upon it, was so violently purged for about two days, that it brought Convulsions and a Spasmus Cinycus upon her, which

was not removed in three Years.

A Physician, to whom I communicated several things, sent me the following Account in a Letter from Dublin, dated Feb. 27. 1682. viz. That he found the good Effects of Ens Veneris in removing the Subsultus Tendinum, in a Febris Petechialis, which was fatal to many for about

fourteen Months.

The Method I took in this Feaver was, if the Patient was costive, first to prescribe a Glister, and a large blistering Plaster between the Shoulders, keeping it running 'till the Declension of the Distemper; all this time I prescribed Emulsions of Aqua Aronis, Card. Bened. Citri, totime Syr. Gratorum cum Aceto, Orange and Buttermilk Posset, &c. I avoid the use of all those things that quicken the Circulation of the Blood; and I rather prescribe Blistering to prevent, than cure Affections of the Genus Nervolum,

fine, because the Matter being once fixed in those Parts, they become ineffectual.

A designed Chymical Medicine.

Confidering that the Menstruums usually employed in opening and preparing the Body of Steel were Acids, I tryed to do it in the following method. Having dissolved fresh filings of Steel in a warm place, in a sufficient quantity of Spirit of fermented Urine highly rectifyed per fe, the filtrated foliation had a taste different from all other Chalybeat preparations, and being fet in a cold Window; in three days precipitated a powder of a green colour, yet the decantated Liquor by Evaporation would not in the least Cristalize. This Preparation hath effects quite different from those Preparations made by Acids, and is much more agreeable to some Persons.

A designed Chymical Medicine.

That I might try whether a Metalline Sulphur might be obtained from Steel, I pitched upon a Menstruum void of Sulphur, that if the Preparation should yeild Sulphur, it might not be suspected to come from the Menstruum. Wherefore I dissolved Steel in Spirit of Sca-salt, and upon Evaporation obtained very curious Cristals, from which we drew by Distillation in a Retort, a good quantity of Liquor, which came over in the form of Steams, which had a very Sulphureous smell, which being rectifyed and mixed with Aqua Fortis would

would dissolve Gold, and give it the colour of Silver; which may intimate to us, how much the Vitriols of Metals may differ according to the difference of the Menstruum which diffolve them, fince our green Vitriol affords Liquors different from that made with Ovl of Vitriol. Besides which, it may be worth while to note, that though neither common or Roman Vitriol will diffolve in Spirit of Wine, which is Inflamable, yet our Vitriol would readily, and here it will not be unnecessary to hint by the by, that a folution of our faline Vitriol may not improbably be of use in Wounds, being a very powerful Astringent, and fit to prevent the breeding of Worms in Wounds, disposed to abound with fuch in cold Climates.

But what we cheifly designed in this Experiment, and what is most to be taken notice of is, that the dry substance, raised by the fire, was distinguished by accidents into three kinds of fubstances. First, a Powder which when exposed to the Air turned yellow. Secondly, a deep coloured substance betwixt red and brown, of Parts much groffer than the former. Thirdly, a substance of a shining red, whose

Parts were very fine and fubtle.

The Caput Mortuum was changed into a Talky fubstance, confisting of Lamella, fituated and connected much after the same manner, as the thick Plates which make up Muscovia

Glass.

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CHAP. VII.

Experiments and Observations Solitary.

EXPERIMENT L

A notable Comminution of Gold into Powder, that will fink in Water,

TE dissolved a grain of refined Gold in nutri Aqua Regia, adding about two spoon- Powder. fuls of Water to the Solution, in which Mixture a fmall piece of Metal being suspended, it in s few days afforded a deep coloured Precipitate, which was fo light that it was a confidemble time in subsiding, and as easily raised in the form of Mud upon an Agitation of the Vessel; where it was to be noted, that tho' upon an Agitation the Liquor at the first seemed Opacous, yet in a little time it appeared to be of ine Purple colour, fo that the Particles of Gold were so far divided, as by being scattered through two ounces of Water to give a Tindure to it.

EXPERIMENT II.

A Proof of the Metalline Nature of Granates.

In Confirmation of what I have elsewhere The Mitaldelivered, viz. That the Virtue of Gems de- line Nature pends on a Mixture of Metalline Juices, with c.& the Particles of those Gems whilst in fluid forms,

forms, I shall take notice, that a Granate of a dark colour, being applyed to a Load-stone, it so strongly attracted it, as not without violence to be separated from it.

EXPERIMENT III.

I am told by an Ingenious Gentleman, that he faw a flat Saphir in the East-Indies, which had a small Cavity in the middle of it filled with a fluid substance, which was not so apt to petrysie as the rest.

EXPERIMENT IV.

To prove that Fishes hear under Water, I shall here lay down a Relation which I received from an Ingenious Gentleman, who in a Garden near Genoa, observed the Gardiner to assemble the Fishes in the Pond together, by a certain noise which he made.

EXPERIMENT V.

To illustrate and confirm what hath elsewhere been observed, concerning the various colours refracted by the minute and Parts of Solids, I shall here note, that a Globe of Rock-Crystal being sawn in two, the new superficies refracted the Rays of the Sun, so as to exhibit colours more lively than those of a Rain-Bow, which were refracted this way, or that, as the superficies of the Stones were differently situated in reference to the Sun-Beams, and the like Phænomena succeeded the like Tryals



Triels with a Touch stone. Which Experisens may confirm what hath elfewhere been delivered, concerning colours of Bodies depending on a peculiar modification of Rays of light, on the faperficies of Bodies different from each other in other Qualities.

EXPERIMENT VI.

Having put into a Glass-Vessel an Oculus Modi, whose Diameter was about a third of an Inch, the Colour of which was white, and its figure Convex, by degrees the whole was turned brown; and in nine minutes time being taken out of the Water was Semidisphanous, which being a gain put into the Water, and after a little less than half an hour taken out again, was almost as yellow and Deplances as Amber. But being for some time appoind to the Air, it began gradually to grow Opecous, and to be marked in feveral places with white ftreaks, which by degrees expanding themselves, united so as to make the whole Surface of the Stone of a cream white.

EXPERIMENT VII.

Remarkable Observations about Hurricanes.

am informed by the Governour of the Observaribermudat Islands, that these are the foreruners Hurricanes. them, First, at some distance from the flore the Sea would swell. Secondly, the Water about a day after would beat violently against

gainst the shore and adjacent Rocks, which could neither be attributed to Winds or Tydes or any other cause; besides which it would fometimes on a fudden invade the shore faccessively, as suddenly subsiding again without any manifest cause, where it is observable, that as the incroachment upon the Shore is greater. the recess of the Water is proportionable. Thirdly, an unpleasant smell in the Air would preceed the Hurricane. Fourthly, long and visible ftreaks appeared in the Air of very different Colours, as white, blue, red or green, without the least appearance of Clouds.

EXPERIMENT VIL

A Monstrous Pearl.

Yester day was brought to me a Pearl of an Front Panel. Orient colour, except one spot which I suposed was the place where the Umbelical Cord fastened it to the Shell, it was an Inch and a half long, and about sof an Inch broad.

EXPERIMENT IX.

A strange Observation about the Influence of the Moon.

Observati-I am informed by a Gentleman, that upon a fall had several pieces of his Skull taken out, that he not only observed pricking Pains at the full of the Moon about the Meninges, but like wife, that the Chirurgeons perceived an Intumescence, and expansion of those Parts.

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EXPERIMENT

An uncommon Experiment about Heat and Cold.

For a further Confirmation of our Doctrine of the Origin of Heat and Cold, I shall lay down and Cold. the following Experiment; we immerfed the Ball of a Thermoscope Hermetically sealed in a Cylindrical Vessel, which contained Oyl of Vitriol, and presently cast Sal-Armoniack into the Oyl, upon the Mixture of which there fucceeded a violent Ebullition, and likewise a gradual fuccession of coldness, which was both perceived by touching the Vessel, and likewise by the descent of the Spirit of Wine in the Thermometer; yet this Mixture instead of a cold Effervescensce, presently upon the addition of an equal quantity of Water, became violent Hot.

CHAP. VIII.

A Collection of Chymical Experiments.

Y design in following Experiments, be- A collection M ing rather to lay down fuch as may be Mediciner. instructive to the Reader, than Ostentations of my own skill, I shall give this short Advertisement, that I have upon that account rather made choise of such as are easie, than those that are difficult to be prepared, those being more proper for my defign, which is to lay down

down Fundamentals for compiling of natural Phylosophy, because they are likely to be most Intelligible; for it does not always happen, that that which is most pleasing to the Eye is most useful, for the' Gold and Diamonds are valuable in themselves, yet a piece of Steel or Flint are in effect in some respects, of greater use to Mankind.

EXPERIMENT L

To diffolos crude Gold with dry Bodies.

Tho' Chymists so much boast of their Anish rum Potabile, as to think it a curious preparation, yet it is possible to make one without the help of a furnace, or so much time, after the following manner. Having ground some Parts of pure Nitre with two of Rock-Allon, and one of Sal-Armoniack, I put the Mixture into a new Crucible, keeping it in a moderate Heat, till the Mixture contained in it was dry, which being taken out, and presently pulverised, it afforded a Golden Tincture in highly recifyed Spirit of Wine.

EXPERIMENT II.

Luna Cornea by Distillation.

Luni Cord Three ounces of Silver being put into a Renea by Difillation.

Three ounces of Silver being put into a Refillation.

fittong Fire the Sublimate was carried to the
top of the Vessel, leaving the Silver half melted, and turned into a Semidiaphanous hor-

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by Substance, which would melt at the flame of a Candle like Wax.

N. B. That if there be any Phænomena in this or other Experiments, above what the Title promises, the Apology I make for them is that as they may tend to the promoting of natural Philosophy as well as the other, fo I was not willing to pass them by without Nonce.

EXPERIMENT III.

Mercury growing warm with Silver.

Having gradually mixed the precipitate of Silver made with Copper, with two drachms of warm with Antimonial Mercury in a Man's hand, till it had reduced to a yielding confiftence three quirters of its own weight, we put the Amalgama which was noted to be fensibly warm during the Mixture, and of an uniform confiftence, into a Glass Vial, which in two Nights time became a hard and brittle Concrete.

Mercury growing

EXPERIMENT IV.

The lasting Disposition of a certain preparation of Mercury to grow Hot with Gold.

I fent a Mercury to the Royal Society, which was prepared with a great deal of pains in my Fornaces, which being mixed in one growing hand with a due proportion of Calx of Gold, Gold. might be perceived to acquire a fensible Heat, which faculty it retained being Hermetically B b *

Mercury

fealed

fealed in a Glass Egg ten or twelve years. And what is more remarkable is, that the Mercury being separated by Distillation, would when mixed again with Gold reiterate the former Incalescence.

EXPERIMENT V.

An uncommon method of working upon Antimony.

A particu-

In the common method of operating upon Anlar way of timony, the Air not only influencing the fire on Antime in its Operation, but also bearing up several of its Particles which work upon each other as in a Medium, I took the following method to try what effects the fire would have upon it, viz. I laid SSS of common Chalk and Antimony powdered, in an Earthen Pot, and placed it in a digeftive Furnace, where it continued about twenty four hours, having taken care that the first and last Stratum should be of Chalk, and that the Layer of Antimony should be pretty thin.

EXPERIMENT VI.

A method very uncommon of making a Calces of Gold.

Calces of Preparations of Gold being usually taken Gold. for extraordinary Medicines, I shall lay down one, which is a Calces prepared without the help of corrolives Menstruums. Having dissolved Gold in Aqua Regia, and distilled off fo much of the Menstruum as to leave the Gold dissolved



diffolved in fo much of it, as to refemble a thick Oyly Liquor, upon which Inflamable Spinit of Wine, being poured, a red Calx presenly fabfided; and the like Precipitation fucceeded upon mixing Spirit of Wine again upon the decanted Liquor, which was very much sweetned by the first Infusion; and this Calx is not only more subtle, but milder and fafer than common' Preparations, and may be made yet more fafe, if Spirit of Wine be foccessively poured upon it, and confumed by Deflagration, for by that means the relidue, if there be any of corrolive faline Parts will be carried off; but there is one thing to be noted here, which is, that amongst this Calx there were feveral Particles which shined like Gold. to that there ought to be more than ordinary care in the Preparation to dissolve the Gold perfeelly. N. B. This Menstruum is not only in this but several other Preparations preferable to common A R, because the Inflamable Spirit being mixed with it renders it more Spiritnous.

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EXPERIMENT VIII.

To try how much Volatile Salt might be dissolved in Water, we put a quantity of them both together in a moderate Heat, and found that an ounce and a drachm might be dissolved in three ounces of Water.

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EXPERIMENT VIII.

Salt of Tartar being dissolved in Spirit of French Verdigrease, two or three times successively, and the Spirit being as often drawn of hy Distillation, the Salt remained in a disposition to be dissolved in rectifyed Spirit of Wine, and apt to be brought to Fusion.

EXPERIMENT IX.

To make an Inflamable Spirit of Roses.

A quart of Ale-Yest, being kept in fermentation five or six days together, with two bushels of Damask Roses and red Rose Bods well beaten, yielded an Inslamable Spirit being distilled per Vesicam.

EXPERIMENT X.

About the Chymical Analysis of Pearls.

AChymical Analysis of Pearls.

From two ounces of Oriental Pearls distilled in a Retort in a sand Furnace, we obtained a black Oyl which swam upon an Opacous and muddy Spirit, both being in weight about twenty three grains; and from the top of the Retort to the bottom was extended a film of Oyl which was about three grains, being of a fetid smell and discolouring Spirit of Wfne with a redish brown Tincture, the Oyl and Spirit also resembled Harts-hern in smell, and the latter had all the Qualities of a Volatile Alkaly,

s to turn Sublimate white and Syrup of Violets green, and to ferment with Spirit of Salt. The Caput Mortuum which was black being calcined became white, being of a hot and bitterif tafte, and capable of turning Syrup of violets green. As also when mixed with a So-Intion of Sublimate it would yield an Orange coloured precipitate.

CHAP. IX. Of Strange Reports.

RELATION I.

I have been informed by a Physician who Strangere. or four Resuscitable Plants, and I am likewise told by a certain Virtuofo, that he faw two which an Ingenious Apothecary in Namur had prepared, viz. Carduus Benedictus and Camomile, and tho' Quercetan alledges, that for the production of fuch and their continuance. actual Heat is requisite, yet this Apothecary put the ashes of those Plants into such a Liquor, that upon an agitation of the Bottle the dispersed Particles of the ashes would convene into fuch an order, as to represent the Plant whose ashes they were, and that they would continue fo till the Vessel was agitated aagain.

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RELATION II.

I am informed by a Chymist of good Credit, that he was not only told by a Virtuoso of Switzerland, that he had a piece of Malleable Glass, but laying it upon an Anvil, and striking it with a Hammer, he found it to receive the Impression, and to grow thinner after a few blows, though the edges were cracked like those of Silver when over Hammered.

RELATION III.

I am told by a Pious Man who stayed in London in the Year 1665, when the Plague raged there, that in some places the lafection was so strong as to stain the very Walls, so that a Pest-House being only divided by a Wall, he perceived several spots on the Walls of his Study, he visited at least a thousand, and only took half a spoon-of Brandy about six times a day, and the quantity of a Nutmeg of the Root of Spanish Angelica, a grain of which he usually held in his mouth, when he visited Insected Perfons.

RELATION IV.

I am informed by a Person of credit, that he distilled for a German Physician a certain Mineral, which he gave me a description of, which afforded three drachms of a Liquor which

which put into a Glass-Bubble with a neck, would upon the full Moon rife up into the neck a confiderable height, which Expansion it loft as the Moon decreased.

RELATION V.

An ingenious Gentleman, who had distilled a certain Bismute or Tin-Glass for a German Prince, there being a Mine of it in his Territories, informed me that the Liquor distilled from it, being rectified would swell and subfide upon the increase and decrease of the Moon.

RELATION VI.

I am informed by an Ingenious Person who refided in Prussia some time, that several Swallows which were found upon breaking of the Ice enclosed in it, recovered and flew about the Room when thawed, though none of them farvived four days, some of them dying sooner.

RELATION VII.

Iam informed by a Traveller that returned from Jamaica, that he saw a Silk-Cotton Tree which was twenty one-yards about, which grew upon a certain Mountain; and that the ordinary fort are as large as Oak trees in England.

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RELATION VIII.

I received the following account from an East-India Merchant, viz. That at Campus and Rahan on the East-Coast of Sumatra, there constantly happens a violent Indraught of the Sea called Bunna which approaches with a terrible noise, in three Parts, the first and last of which are more moderate than the second which is very high and terrible, and comes with such force, that no Vessel, except Anchor be weighed is able to resist it, and this Bunna constantly returns at new and full Moon. The reason of which the Relator attributes to the greatness of the Spring-Tides, which come rouling over Banks of Sand, which choak up the mouth of the River.

RELATION IX.

I am informed by a Gentleman, that being at Sea near the Coast of Mosambique, the Captain observing a dark speck in the Sky a distance off, takeing it for a sign of an approaching Storm, took in the sails, and tho' the Sky was for some time after calm, yet on a sudden a Hurricane arose, which turn'd the Ship several times round, as if it had been in a Whirl-Pool, and this Storm continued near two hours.

RELATION X.

I am informed by a Phylician, that he faw in the Country near Armsterdam, a fort of Mercury in the custody of a Farmer, which was of a Golden colour throughout, and would if put upon the fire in a proper Vessel precipitate in the form of a red Powder.

And I am likewise told by a Judicious Physcian, that he saw in the possession of a Stranger, a fort of Mercury whose small Globules

were of a green colour.

CHAP. X.

Various Observations about Diamonds.

lamonds being not only the most Noble Observatibut Valuable amongst Gems, it may be one about Diamonds. worth our while to consider them a little, and to relate what Observations I have been able to make about them. And,

I. It is observed, that Diamonds are so much harder than other Bodies, that they require a greater force to cut and polish them than other Gems.

II. It is observed by one who hath long dealt in Diamonds, that those which are now brought over are much fofter than those of the old Rock.

III. The Tradition is false, that Diamonds cannot be cut without being foftened in Goats Blood, the contrary being found by Diamond cutters, cutters, and an Experienced Diamond-cutter hath informed me, that he uses to polish Diamonds with the dust which he obtains by pounding of boared Diamonds in an Iron Mortar.

IV. Tho' it be a general received Opinion, that Diamonds have a weight proportionable to their Solidity, yet I find amongst my Experiments, that a Diamond being weighed Hydrostatically in Wattr was to its proportion of that Liquor as 222 to 1, so that it did not equal its treeble proportion of Water in weight.

V. I am informed that if Diamonds be Cloudy, fometimes one as big again as a Pe, will be at least four grains heavier than another

of an equal fize.

VI. The natural shape of Diamonds is uncertain, since most of them which we see are only broken pieces, whose sigures are very irregular, yet I have seen some which seemed to consist of Triangles terminating in solid Angles, and I am told by one who cuts a great number, that those which are of a regular Figure are usually four corner'd.

VII. It is observed, that in Diamonds there is a regular tendency of Fibers or thin Plates, which lye parallel to each other, which may be called the grain of them which way they may easily be divided, tho' not against that grain

without difficulty.

VIII. As to the colour of Diamonds, tho it generally be so well known, as not to need to be described, yet in the East-Indies some have been observed to be of a pale blue colour: And Monsieur Tavernier says, he hath seen one



or of a very red colour, and a Relation of mine wore a Diamond in a Ring which was of Golden yellow; besides which varieties of colours. I have observ'd one amongst a great many in the East-India House whose colour was green.

IX. And I have feen a Diamond brought from the East-Indies, which had fix Triangular fides and a Cavity in one of them, in which Diamond the Fibers might eafily be difcerned. And the Merchant to which this belonged, told me he had feen one brought from Borneo, which before it was Polished was black.

the after it appeared to be a clear Stone.

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K. To conclude this Chapter, I shall add the following Relation, which will contenance what I have elsewhere related, viz. That the Virtue of Gems may probably arise from Metalline Tinctures incorporated with the matter of them, whilst it was foft and fluid; the Observation is, that having applyed a Load-stone to a small Diamond which was pretty dull, it would not only be taken up by it, but would at a considerable distance leap up to it. To these Observations I shall only add, that there are feveral other Observations which are scattered up and down my Writings, which I shall not repet here, they properly enough belonging to those writings.

THE

WORKS

Of the HONOURABLE

ROBERT BOTLE, Efq;

EPITOMIZED.

BOOK V. PART III.

CHAP. I.

Of the Original and Virtue of Gems.

Gems are endowed with fo many Medicinal Virtues as are usually ascribed to them; yet I believe they may have considerable Effects on Humane Bodies, which Virtues they may receive from the Intermixture of Mineral and Metalline Parts, whilf they were in a fluid form. And that precious Stones have once been in a fluid form, may be argued hence, viz. First, from their Diaphaneity;



spheneity; fluid Bodies being more apt to have their Parts ranged in an order requifite to transparency, than folid Bodies; as Silver diffolved in Aqua Fortis, and Lead in Spirit of Vinegar, not only become transparent, but may form Diaphanous Crystals. Secondly, from their External figure; it being usual for Bodies to form more regularly and curioufly shaped Crystals when in a fluid, than a solid Ambient substance; for which Reason, if a Glass-Bottle be filled with a Solution of Nitre, and the Water hath been pretty well confumed by boiling, the Salt will shoot into a Mass, whose fide next the Glass answers the form of it, but that next the Water will be fet with Prismatical Crystals of a Nitrous figure: And I have feen Indian Granates taken out of a lump of Heterogeneous matter, fome of whose Surfaces were Triangles, others Paralellograms, &c. according the figures of the Cells they were contained in. And I have feen not only Bristol Stones, but Cornish Diamonds curiously shaped like Crystals of falt Petre: And I have likewife feen Rubies very Geometrically shaped; and amongst other Rarities, a Diamond whose Surface confifted of feveral Triangular Planes, which contained feveral lesser within them, which for the most part met at a Point, and formed an obtuse solid Angle. And I have observed, that most Diamonds have angular and determinate shapes.

And in favour of the Hypothelis already laid down, I shall add, that precious Stones being dislibited in a Particular Menstruum, they boot into Crystals like those of Nitre, but

infipid.

infipid. And I have observed, that the' Bride Stones have on the upper part, fix fmooth fides which were fo cut as to represent fir fmooth Triangles, which terminate like the of a Pyramid in a Virtex, yet the lower Part which was next the matter it adhered to, made it appear less transparent, and conformable in figure to the Cavity of its womb, this is more remarkably evident, when clusters of the Crystals grow out of one Mineral lump. And to this I shall further add, that I have feen a Mass which consisted of two flat Parallel Cakes. which seemed to be composed of a dirty kind of Crystalline substance; and out of each Cake there grew towards the other a great number of Stones, which having a little space about them, were regularly shaped, and of the colour of a German Amethyst. And I have a Stone which confifts of four Parts, the lowest being like a flake of coarfe Stone, only adorned here and there with very minute glittering Particles, as if of a Metalline Nature; over this is spread a thin white Opacous bed, and the third is made up of a long feries of Crystals thick fet, and which look whitish; and upon these which are not much thicker than a Barly-Corn, lyes another made up of Crystals like Amethyts, fome higher tinged than others, and more elevated where they had most Room to shoot; those that were most elevated being hard enough to grate lines upon Glass. And I have found in the Cavities of concreted Stones Crystals which were fet round the fides of them, and feemed to be formed of a Lapidescent Juice, which was Percolated through the fubstance of the

the Stones, and formed curioully shaped Crythe And I am told by a digger, that he buth observed several clusters of these Crystals which stuck to no part of the Rock, but seemd to be hastily formed in a foft Mould.

But thirdly, not only the External but their Internal Texture favours our Hypothelis; fince it feens to imitate that of those Bodies which have been formerly fluids: For it hath been observed, that feveral Particles of Salt sticking together here not only formed large lumps, but Sal-Gem and lumps of the Isle of Mayow Salt being broke feemed to be made up of the like Parts. And the a folution of Silver usually floots into thin Plates, yet it may be so ordered, that several of these joining together may form larger Crystals, whose outsides may be finely shaped like some peculiar kind of Vitriol. And tho' transparent Bodies are usually thought to be of an uniform Texture, yet I have observed, that a thin Muscovy Glass Plate, which was fo thin as to be scarce visible, might be further divided into Plates; and the like hath been observed in other Stones; and to this I shall add, that I have been able to perceive the grain of a large Grizolette with my Eye, as well as in Hyacinths and Saphirs; and English Granates when they are broke, appear manifelly to be made up of flakes or Plates; and so do even Diamonds themselves, which are observed to cleave much more easily with the grain than against it, as Wood is observed to do, which is made up of an affimilated Juice which was first fluid: But it is observed in some Diamonds, that the flakes are not wholly parallel. Parallel, but in the substance of the Stone, fometimes make Angles; for which reason some of them break in pieces before they will

cleave through.

Fourthly, it feems requifite, that thefe Stones should have been in folutis Principiis, that they might be tinged with Mineral Juices. Which proposition suggests several Observations; and First. That most Gems lose their colour, or have it altered by the fire, and tho' it may be fuggested, that the loss of a colour may be effected without the addition of a Pigment, by a change of the superficial Texture of a Body; (as when red Ink is beaten into a froth, or when Crystal receives several flaws in its Surface, by being suddenly cooled in Water, and becomes white, or in Cochinele, and puts on a pleasing colour, by the infinuation of the Tincture into the cracks and flaws) yet Indian Granates are observed to change their redish for a dark and dirty Iron colour, and Agats being kept a competent time in the fire became white, except where Mineral Veins ran, where it was observed, that the colour was not destroyed but changed, and became a deep red, tho' I suspected that a more lasting fire would have turned them white, and the like change of colour hath been observed in Pebbles, and other Stones, some of which losing their Transparency by Ignition, acquired a deeper colour upon their Extinction in Water, to countenance what I have laid down, it may be further offered, that Gems are generally found near Mines, or Mineral Veins; and the they are not fufficiently skilled in digging Mines

Mines to discover what they otherwise probily might, yet I have feen feveral Amethyfts which were taken out of Ground abounding with Iron and Tin Ores; and those softer Gems called by Mineralists Fluores, are often to be found in or near Metalline Veins, finely finged with Mineral Juices, which were they in hot Countries and fufficiently hardened with the San, they might pass for Emaralds, oc. And I remember, that I once prepared a Menstruum no more corrolive than white Wine, which being poured upon well coloured Granates exmided a lovely Tincture from them. Bervenuto Cellini tells us, that he faw a Rubie which was not of the usual colour but white; a also he acquaints us, that he hath feen Berils: Topazes, and Amethysts of the same colour; and Rubies and Saphirs have been observed to be of the same degree of hardness, so that they were looked upon to be the fartle kind of Stone tho' differently tinged; and that the fame kind of Stone may be differently tinged appears, fince Diamonds have been observed to be yellowish, more yellow and perfectly jellow, bluish, greenish, and some as green as Emaralds. And one who lived near the River Siam or Pegu in the East-Indies told me; he had feen Stones taken out of the Water partly void of colour, and partly of the colour of a Rubie. And belides what I have obsetred in Agats and Opacous Gems, as to the differing colours of the same Stone; I weat a Sardoinx in a Ring, the uppermost part of which is black, the middlemost of a Chesnut, tol the other of a blue colour, almost like Cc*

a Turquois, and each of these of an uniform breadth and Parallel to each other, and even amongst Saphirs tho' they are commonly azare yet a white Stone hath been called by the fame name, because of the same degree of hard ness. And to these I shall add, that in Itahi have feen a large piece of Crystal, whose Prramidal part was of a trnfparent green; the Vertex being richly tinged like an Emerald: but the further the colour spread from the Vertex, the more dilute and pale it grew, to that the Base was transparent and like ording ry Crystal; agreeable to which Fosephus Arofts fays, that Emeralds feem to grow in Stone like Crystals, and by little and little to thicken and refine. He likewise says, he hath seen some balf white and balf green; others all white, and some green and very perfect. And I have feen a Saphir fo odly tinged with Mineral fume, that it might well be taken for a Chalcedonias, tho' of the hardness of a Saphir.

And to shew further, that solid Gems may include Heterogeneous matter in them; I shall add, that not only I but others have perceived something in the Body of Rock-Crystal, which by varying the posture of that Stone might be rendered visible; and the like hath been seen in Grisolets brought from the East-Indie: And in a hard Stone brought from thence, and designedly broke, I found several clear and transparent Crystals, which had their Points inwards, and were Arguments that they had swam in some Liquors, whose incoagulable Parts were either imbibed by the Ambient matter or penetrated it. And to illustrate

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that I have faid I shall add, that I have not only feen a Fly in shape and fize much like a Grafs-hopper, enclosed in folid Amber, but perionly and curiously coloured with his wings diplayed. And I have feen white Amethifts which there appeared to be feveral lines, fome of a brownish and some of a reddish colour, which looked like hairs, fome lying Parallel to each other, and others more inclinat and I am apt to believe, that even Diamonds are not void of Particles of Heterogenote matter, which is countenanced not only by odd Clouds which I have feen in a great may of them, but the different specifick Granity of those of the same Water, the difference amounting to aCarrat betwixt Diamonds of the fize of two ordinary Peafe.

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But, besides what hath been already offered, to prove that Gems have been once in a fluid form, it may be further alledged, that the Mineral Particles which they are fo uniformly tinged with are convincing Arguments, fince it inconceivable how they should otherwise be so impregnated. And to what hath been aready delivered; I shall further add, what is delivered by a French Author, viz. That the Stones which are found in the Earth have their Water coloured by the Earth, whether it be ht and black, or abounds with black or red Sand, and in some the Gems have been observed to be black or yellow; but the' this Authe hath faid thus much which countenances our Hypothesis, yet I must not omit to advertile that the' he afferts Diamonds to be not only the hirdest but heaviest of Stones, I must yet

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a Turquois, and each of these of an uniform breadth and Parallel to each other, and even amongst Saphirs tho' they are commonly azure vet a white Stone hath been called by the fame name, because of the same degree of hard ness. And to these I shall add, that in Itahi have feen a large piece of Crystal, whose Prramidal part was of a trnfparent green; the Vertex being richly tinged like an Emerald: but the further the colour spread from the Vertex, the more dilute and pale it grew, h that the Base was transparent and like ordinry Crystal; agreeable to which Fosephus Angle fays, that Emeralds feem to grow in Stone like Crystals, and by little and little to thicker and refine. He likewise says, he hath seen some balf white and balf green; others all white, and some green and very perfect. And I have seen a Saphir fo odly tinged with Mineral fune, that it might well be taken for a Chalcedonia, tho' of the hardness of a Saphir.

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fay, that they are not the heaviest as may be

Hydrostatically discovered.

But perhaps against what we have faid, It may be urged, first that the figures of these Crystals are so curious, that a Plastick or Seminal Power feems requifite to the forming of them; which were it requisite, it might be anfwered, that that Plaftick Power may be lodged in fluid as well as folid fubstances, since the solid Parts of Animal Bodies as well as Plants are formed of liquid substances; but that the figures of these Crystals may be owing to an apt convension and coalition of fluid Particles may be argued hence, viz. Since common Salt, by the help of Oyl of Sulphur or of Vitriol and Water, will shoot into Crystals with Points like Diamonds, and not unlike native Crystal in shape and transparency; but if the Quality or proportion of the Oyl of Vitriol be varyed, they will shoot into Crystals sometimes of one shape and sometimes of another, for the most part finely figured. And to shew that the regular figure of Sea-falt contributes not to fuch figurations, I shall add, that having dissolved some Stony Stiria, found in Caves or Grottoes, in Spirit of Verdigreafe, and evaporated the clear folution in a digestive Furnace after the ordinary manner, it yielded rather a coagulated Mass, than any thing like Crystals; whence it appears, that a concourse of circumstances may be sufficient to determine the figures of confiftent Bodies, made of fluid ones; especially since when I allowed a longer time for the fluid to shoot in, it afforded a good



d number of distinct Crystals; long, transent, and curioufly shaped.

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not only the external figure of Crylised Bodies may be accounted for, without telep of a Plastick Power, but their inter-Construction likewise, since divers Bodies on a flow coalition will form Concretes, of which will confift of streaks, and oof flakes; as lumps of Sal-Armoniack, d tho' a factitious Body, when broke will ar to be full of streaks, like those Stirie aved in petrifying Water. And I have cartificial Concretes of Salts alone, or of or Minerals, as Stones, or Antimony look very like Talk, being white Bodies de up of a multitude of streaky Particles, glong ways one upon another as in that and I have not only found Concretes d like Rhombus's or Lozenges, composed a multitude of flat and extreamly thin Plates, have imitated such by Art. And I have of Silver, that the generally Crystals of Silver find flakes feemingly simple like scales of Fishs, jet when they have shot leasurely they are Geometrically enough shaped, and made up of flakes sticking one to another. And Tin-Glass which naturally confilts of a multitude chining and polished flakes, will, tho' beaten lo Powder, and melted, upon its Refrigeration form feveral broad and shining flakes, which Jing one upon another, crofs each other at Jarious Angles, as the matter happens in fereral Portions to be variously refrigerated. And the like instances may be observed in fome Mixtures of Copper, Iron, and other Cc3

Minerals;

Minerals; and very confpicuously in good Reput lus Martis Stellatus, whose internal structure appears upon breaking of it, to be made up of fhining flakes, almost of a specular Polish, And tho' whilst we are looking on some Concretes. the Stony Stiria in some places have a streaky and in others an angular Configuration, yet I have feen feveral of them made up of Parts confusedly jumbled together, and if there be a due disposition in the components Parts to such Configurations, they may be brought to Concretes in a far shorter time than any one would expect or believe; fo that a folution of Silver being heated hot, and removed fuddenly into cold Water, one might not only very eafily. but plainly fee the Silver shoot with ones naked Eye; but even a strong Solution of Sal-Armoniack, or some Urinous Spirit, being spread upon the outfide of a Glass in which a frigorifick Mixture is contained, will in less than a minute of an hour be coagulated into Crystals of a determinate figure, according to the Nature of the Liquor that afforded it.

But if against these instances it be urged, that the they are taken from saline Bodies, which are for the most part disposed to convene into smooth Surfaces, and Angular shapes, and are easily wrought on by External Cold, yet it may seem strange, that the figure of a Mould or Womb should alter the Internal Construction of solid Minerals and Gems; but that it may is evident, since, the Tin-Glass consists of several smooth and bright Planes, which sometimes meet, and sometimes lye a-

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other, at very different Angles, yet eaten a fufficient quantity of it to Powwhen it was melted cast it into Iron whose Cavities were each an Inch in er, it formed a Bullet, which when broke seemed to be made up of a multiof fhining Planes, so shaped and placed they rought every way like so many Radiand a Sphere tending from a Centre to the Grumference, fo that they feemed gradually to includes they were removed further and furfrom the Circumference. But if the mel-Tin-Glass was permitted to cool in a Cruale, the hardened matter would form several s irregularly and confusedly associated to-And the like Experiment being tryed Regulus of Antimony it succeded, the' not so uniformly as with Tin-Glass: And melted Sulphur being hardened in the same Modes, the Concreted Mass seemed when broke to confift of flakes like Straws lying Prailed to each other : But how the flakes of The Glass came to be so regularly situated; and whether the outside being first condensed, the contiguous Liquor was connected by apposition, successively as it moved within the crosted Surface, or whether it was otherwise ciched, I shall not now stay to examine; but to what I have faid I shall add, that having broke several Marchasites of a peculiar fort, I found them to confift of feveral rows of Planes reaching from the inermost Parts to the External Surface; and in those which were somewhat Cylindrically shaped on the outside, these Ranks of Gold coloured Particles, in the feve-

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sal Planes of the broken Mineral seemed like Semi-Diameters issuing out from from a row of Physical Points, conceived to be placed of an Imaginary Line; lying almost like the Are of a Cylinder between the apposite ends; a if the Wombs wherein those Marchasites were found, contained the fluid matter as in Molds, and as if it Concreted there, as Tin-Glass or Re-

gulus did in the Molds.

But tho' from hence it may appear, that tho' the figures of fuch Concretes be curious enough; yet they may eafily be accounted for without a feminal Principle, yet I find not the uniformity of the figrue always fo great s is imagined, but rather to depend on the different Figure and Texture of the Wombs they are contained in; for comparing America, African, and European Granats together, ! found that one which weighed eleven grains and a half, tho it feemed to have been coagulated in a fluid Medium, and to confift of twelve Plains, at the concourse of two or three of which it seemed to have been broken off from the Root or Womb, yet it was not of the Ddecabedron of Geometricians; for whereas that confifts of twelve equilateral and equiangled Pentagons; almost all the Planes that made up our Granate, were quadrilateral, and not of a regular shape or Magnitude; for one of them feemed to have five fides; others refembled a Rhombus, fome a Rhomboides; but most were a little bigger than the Trapezia. But, besides the want of uniformity in these Stones, I observed amongst Cornish Diamonds, that some of them were cotiously and Geometrically shaped like Rock-Crystal,

al, having each fix fides, whereof every that were opposite were equal to each other; and the the Stone had a Pyramidal Tertion, made up of several resembling and orioully figured Planes, that terminated in a fild Angle or Apex, yet the greatest number of the Titular Diamonds were made up of very irregularly shaped Stones; for the' most of them had fix long Planes, yet the opposite were most of them irregular and unlike; and the Apex was made up of Planes apart ly Angular, yet being compared with each other they were far from being uniform; tho' a speared that they shot in a fluid Ambient, except at the bottom where they were fastned to the Rock. And I have observed a great bregularity in the Area of the Superficial Planes, or their figures, or both, in Diamonds brought from the East-Indies.

Having shewn that the figures of Stones are fir from discountenancing our conjectures of their Originals, I shall proceed to shew, that they help to confirm them; fince I have feen a finall Cornish Diamond so bedded in a large one, that it left a Cavity in it when separated, and on the contrary I have fometimes feen a large one so joyned to a smaller as to form a Cavity within it, which is a likely Argument, that the one being first hardened, afterwards a for matter was collected together, and being contiguous, hardened in such a form as to contain part of the other in the Cavity, which was formed whilst the one was fluid, and the other was hardened; which may be illustrated by confidering, how Nitrous or Aluminous

Salts

Salts falten themselves about pieces of sticks, and leave a Cavity proportionably to the solid contained: To which I shall add, that I have seen a Stone which was taken out of a Silver Mine, which had coagulated about the Branches of a Silver Wire, which was produced by Nature in the Mine.

Another Argument of the fluid state of Gems, and their Impregnation with Mineral Stems, may be drawn from their Specifick Gravity, for whereas common Rock-Crystal is to its bulk of Water as two and almost two thirds to one, the weight of an American Granate was as four to one. And tho' by this method a tinged Gem hath not so great a difference in its proportion to Water, yet it may nevertheless be impregnated with Mineral Particles, for I found by Hydrostatically weighing Water impregnated with Iron, that it was not much heavier than common Water.

Another Argument may be drawn from the Medicinal Virtues of Stones, and the Metalline or Mineral fubstances, as well from Opacous Stones as Opacous Gems, &c. as the Turquois, the Onyx, the Sardonix, &c. as also Cats Eyes, Opates, &c. And indeed I much question whether Diaphaneity depends on the essence of a Gem; since it may rather proceed from the Position of the Parts of a Pigment, and the scituation of the Pores in reference to the Beams of Light: But waving a further consideration of this matter, I shall rather subjoyn, that precious Stones and even Diamonds themselves, have sometimes great clouds, which makes them in those Parts almost Opacous, with-

less of the Nature of true Diamonds. it is observable that Cornelians and Agats Ome of them transparent, and some of Semidiaphanous, as the Portion of the eral Pigment is greater or less, or as it is or less inconveniently mixed. And I bre feen even a Sardonix transparent, and on the contrary, figured Granates which were both of them Diaphanous : And I have some by me of feveral Countries, which they they er in some places Diaphanous, yet in the main ther are almost as dark as ordinary Stones. and I question not, but that if the Glassy Naare of Gems did not render common Menframs inaccessable, Mineral Particles might be strated from them; and when they are conidenable, I question not but that they may be obtained from folid and transparent Gems; for having kept Granats in a hot Crucible till they changed their colour and afforded a very fine Powder, that being digested with rectifyed Spirit of Wine afforded a curious Tincture; bornt Granats gave Aqua Regis a Tincture, which in some measure resembled a solution of Gold; but a drop of the Liquor being put to a many drops of Tincture of Galls, it turnthem as black as Ink, if not blacker. And the like measures being taken with Granates which were looked upon by fome to be Rubies, the Tincture coloured an Infusion of Galls not quite fo black as the other; but a white Powder was precipitated at the same time; and by the the of an urinous Spirit a redish substance, which being dryed in the Air formed Bodies like Moss, and here and there small Mushrooms prettily coloured.

coloured. And from other Granates I obtained a Tincture, which after evaporation did in the Cold afford faline Concretions, but fo small that their figures could not be determined. And probably, were tryals made, other Mineral Concretes might be wrought on by appropriated Menstruums, for the spar that is found in Lead Mines next the Veins of Ore be Semidiaphanous, and usually breaks in smooth and Glaffy Superficies, and looks like a Talck, and also for the most Part is made up of figured Particles shaped like Rhombuus's or Rhomboides. yet I found it was a more open Body than Talk, being dissolved in Spirit of Salt, without the affiftance of Heat.

But I am apt to believe, that besides the methods already mentioned, there are other methods to discover the Metalline Ingredients of a Body, by Fusions and proper Additaments. And to conclude this Chapter, I shall subjoyn the following Experiment, viz. Having dissolved Stony Stiriæ of petrifyed Water, in Spirit of French Verdigreafe, and after a gentle Evaporation, placed it in a cool place, it yielded stals, figured much like those of pure Nitre, some of this Stony solution being mixed with a folution of Copper, they did not precipitate each other, but upon Evaporation yielded Crystals transparent and colourless, and that were richly adorned with a greenish blue Tincture of the Metal.

CHAP.

Book V.



CHAP. II.

Containing a Conjecture about the Causes of the Virtues of Gems.

ROM what hath been elsewhere, and in the preceding Chapter laid down, it appears, that the Earth does not only abound with feveal Mineral and Metalline fubstances, a great many of which are undiscoverd, and a great many already known, but also that several Mines are furnished with Water, which being impregnated variously, may be no dispicable Minstruums, but may likewise concur to the Production of Mineral Bodies, and not only lerre as corrolive Menstruums, but pure Solvents to Mineral Earths. And that common Water is able to impregnate it felf not only with Saline but Mineral Parts, is evident from the various tasts of Waters, and their uses; fome being fitter for brewing; others for washing; some for dying particular Colours, and some to temper Steel; and others again for other uses: And amongst the most remarkable ies are Therme and Acidula reckoned up by various Authors, as also Salt Springs, and those Waters of Hungary and other Parts, which yield a Vitriol, which is a substance compounded and decompounded, containing a faline, Sulphureous, a Metalline, and an Earthy Part; and if Water may be thus impregnated with Metalline Parts, it is no difficulty to apprehend how a Lapidescent Humour, being sufficiently

mixed

mixed with and proportioned to it, may be coagulated into Stony Stiria, and from such like Coalitions may arise those precious Stones, and transparent Gems; for the Virtue of specifick Juices are so powerful, that I have seen Vegetable substances sufficiently hardened by them to grave on Iron; and I had a substance which I looked upon to be a petrifyed Gum, which was

hard enough to grave on Glass.

And if the Parts of Minerals may thus, by being diffolved in Water, be mixed with a petrifyed Body, by this means Gems may not only be impregnated, but thence receive their Medicinal Virtues, as the Nature of the Mineral is different in Qualities and abounds in Quantity, which Original of their Virtues may be rendeed probable, not only by what hath been faid in the foregoing Chapter, but by their different colours.

And that their Impregnation with Mineral Parts, enobles them with Medicinal Virtues, is evident from the Testimony of Experience, and is rendered probable by the Effects of a Loadstone, which tho a much harder substance than some Gems, emits Effluvia very copionly, and hath not only manifest Effects on Iron, but Humane Bodies. And even those Pebbles with which they counterfeit Diamonds, have been caused in a trice to emit copious and strongly scented Steams; and even Diamonds the hardest of Gems, may by rubbing be caused to emit Electrical Effluvia. And tho' it be thought by fome, that the digestion of a Man's Stomach is not able to extract the Metalline Parts, yet there may be a greater Congruity betwixt the luices



lices of our Bodies, and the Mineral Substanes with which they were impregnated, than we are aware of; besides we see that the Somach bath manifest Effects on Chalybeate Preparations, and even crude Steel it felf. And I have obtained a Tincture from feveral hard Bodies, and even Gems themselves, by a Liceor distilled from a Vegetable substance, as temperately qualifyed as Bread. And that the natural Heat of our Bodies, may contribute to the extracting of the Virtues of precios Stones, I am perswaded, fince it makes an ordent alteration in the hardest of them, so s to render a Diamond Electrical; and I have had one which by warm Water would be excited to fhine in the dark.

And indeed it is not altogether improbable, that Gems having the most subtile Mineral Steams in them, being not dispersed by the action of fire, they may be more Effectual considering their quantity, than Preparations of Metals which have undergone a Fusion. And their Virtues may sometimes be much different, upon the account of a great quantity of Mineral Particles, fince Vunzerus tells us, that amongst those Stones which are called Nephritick Stones, some are much more effectual than others, beides the petrifick Juices themselves may have diffiner natures, and peculiar Qualities, upon the account of their Coalitions with Adreatitious Liquors. And if petrifying Liquors may have fuch manifest effects on several Bodies one would think indisposed to petrify, why may of fuch a Liquor subdue transparent Minerals abounding with Saline, Sulphureous, and Bitu-

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minous Bodies, which being excited may emit their most subtil Parts; and as in the Earth there are fever! Bodies compounded by the adion of Subterraneal fires, those petrifyed man enable the Body with correspondent Qualities: on which occasion I here subjoyn, that I have feen a faline substance which was formed in the Bowels of the Earth, like that which is artificially made. And I have feen Volatile Salts and Sulphurs shoot into transparent Crystals in a fluid Medium after Distillation which have been more curiously figured than feveral Gems: And if it be objected in dietavour of the Medicinal Virtues of Gems, that they grow no lighter when they are faid to emit Effluvia, I shall add, that, not to urge that the Antimonial Cup impregnates Wine without losing of its substance, and that Mercury will give Water a Virtue of killing Worms, by being boiled in it, tho' by these means it loses nothing of its weight, I shall rather demand how it appears, that Bodies grow no lighter by the loss of their Effluvia. And tho' in some cases the Gem may be lighter than Grystal, yet it is no argument of their more languid Effects, fince the specifick Gravity of those Bodies they are impregnated with, may be of a faline Nature, and specifically lighter than Crystal: And I shall in favour of this add, that I have feveral times made Bodies colourless like Crystal; and curiously and regularly figured, which were of a compound Nature, and abounded with an easily separable and ftrongly scented Sulphur. And on this occasion I shall further add, that the when



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it is an Argument of a Metalline substance wird with them; yet sometimes those mineral Particles may be so spirituous, as not to increase their specifick Gravity, for I have seen a ferruginous Water, which, the strongly impregnated, was little heavier than common Water.

And now, if, together with what hath been delivered in this Chapter, we reflect on what follows concerning the Atmospheres of consider Solids, and the efficacy of Effluviums, it will not be absurd to ascribe to precious Stones and Medicinal Virtues, especially to those that

dipoled to emit copious Effluvia.

And to shew that what we have deliver'd, may not only be applyed to transparent but openious Gems; and to render our Hypothesis not only probable, but possible, I shall intimate, sinf. That I have seen lapidescent Juices so penetrating, as to turn several Animal and Vegetable Substances into Stone; amongst which, one was a new Cheese, which could be distinguished no otherwise from another Cheese, but by its stony Hardness; and I have a piece of Wood petrified, which retains its grain, and is hard enough to grave upon Iron or Glass, and to resist the action of the Fire, and likewise to shike Fire like an excellent Flint.

But to render this Hypothesis further probable, I hall subjoin the following Arguments. And, furt, It appears from the Method taken, to weigh Bodies in our Medicina Hydrostatica, where White Marble was proposed as a Standard, to determin whether Metalline parts were in

Dd Bodies

Bodies or not; for a piece of White Marble being in proportion to its Bulk of Water, a 27 to 1; and Blood-stone, as 52 to 1; a Loadftone, as 4 and to 1; Lapis Calaminaris, as 4. to one; and Lapis Tutice as & to 1; It follows that those must proportionably be impregnated with Mineral Parts, heavier in fpecie than Stone; and for that Reason I have found some Stones of the same kind specifically heavier than others, as they were impregnated in Solution Principiis, more or Iess with mineral Parts. But it will not be amis here to advertise, That fome Stones lighter in specie than Fossils, may be compounded with mineral Parts, and thence deduce their Medicinal Virtues; and others may be impregnated with mineral Parts, lighter in specie than Marble, and consequently their mineral Nature cannot be Hydrostatically determin'd as yet, which is to its Bulk of Water, as 1 100 to 1, and yields no inconfiderable Proportion of Oyl.

A Second Argument for the Confirmation of our Hypothesis, may be deduced from the Necessity of it, to explain several Phanomena, as why Diamonds and other Gems shouldbe included in Rocks or Clusters of hard Stones, which must be soft, or could not, at the first, admit a hard Gem to lodge amongst their Parts; and I shall surther urge the Necessity of it, from several Gems which I found in an odd kind of Mineral, sent me from an American Colony. And it is not improbable, that Opacous Gems are petrified Earths, since they vary so much in their Dimensions, so that I have heard of a Spleen-stone which weigh'd 80 Pound weight.





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Ind I have feen a Medicinal Stone, which bein fawed afunder, its internal Parts were full d'Cavities; whence it appeared to be made up approus Earth petrifi'd, and not of an inderated Liquor. From our Hypothesis the folbuing Phænomena may be explained, viz. Why foretimes one part of a Gem is tinged with a Metal, and another is not, fince in making Artifcial Gems, the Mineral Pigment hath tinged one Part without discolouring the other. And I have now by me a lump of petrifi'd Matter, which confifts of feveral Stones, which tho' first parify'd apart, and afterwards joined together by a petrescent Liquor, bear an uniform polish, without discovering betwixt their Parts the last Commissures; and an acquaintance of mine dicover'd feveral loofe Stones, where this was found, which were separately of the same Naure, and afterwards harden'd into stony Masa, by the intervention of a petrescent Liquor. And I have an Agat by me, which feems to confit of feveral Layers of Clay or Earth, lying parallel to each other, and petrify'd partly into Transparent, and partly into Opacous Stones; and to favour this conjecture, I shall add, that I have feen feveral Layers of mineral Earths one upon another, within the compass of a Inch, which lay in different postures, in reference both to the Horizon, and each other; of fometimes the exterior ones fuccessively furrounded the interior; and feveral of these have been found in a small compass of Ground; and by a like Method, differently coloured Chalodonians and Jaspers may be accounted for. And from hence may be deduced a Reason why

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Marchasites and Flints, Wood and Shells, have been found enclosed in other hard Stones. And on this occasion I shall add, that Stones which were partly Diaphanous, and partly Opacous, being calcin'd, the diaphanous Parts became White; and some others which were before tinged, had their Parts heighten'd fo, as after Calcination to be of a rich and permanent Red; and this difference of Colours was not only remarkable in the thin Layers, but in the specks, and irregularly shaped Clouds, whether

Greenish or Bluish.

And to illustrate an Observation formerly made on Diamonds bedded one within another, I shall urge what is observed in Crystalizing Salts, where, as well as in a Metalline Solution, I have observ'd, that when a number of Crystals had shot after the first Evaporation, several fuccessive Layers shot upon those; in the latter of which Solutions, the Crystals of one Layer were not only fastened to the others, but differed confiderably, as well in their Shape as Postures. In this Metalline Solution the Mineral was only one, and the Menstruum simple; but had the first been Compound, there would have been a greater divertity, as likewife Cry-Itals of a compound Nature; as when a Solution of Salt-Petre and Sea-falt in Water is fet to Cry-Stalize, where besides Salts of resulting Figures, a considerable part of the Sea-salt coagulates in the Form of imperfect Cubes about the Bottom, before the nitrous Particles shoot into Crystals of their own shape, And I shall further add, That Crystallization may not only be promoted by Evaporation, but by foaking part of the Water ave

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peither by immerfing it, or by placing dry Earth under the Solution, or some other porous lody. And by fome Analogy to these Instances, we may conceive how some of the superfluous Maisture of a Petrescent Liquor, being disperfed, the remaining may be more apt to coagulate; but by a moist Season or supervening Cold. the moisture ceasing to be further dispersed, the Coagulation may be for a time suspended, and upon that account, upon the second Cryfallization, may yield Crystals less regular, and apt to convene uniformly with the others, then in Artificial Concretions perform'd in difind Vessels. And on this occasion I shall add, That I have had Fire-stones brought from several Places, in one of which, the internal Texture was very different from the more Central Texture; and in another, I not only observed one Spherical Stone contained within another, but of a different Texture, and distinguished by a visible Commissure, tho' the Commissure was not fo uniform as to admit these two to be separated.

But perhaps it may be objected against what we have delivered. That these Bodies are found where petrifying Springs are not. Against which it may be offer'd, not to urge that Men and Beafts have been petrify'd upon the sudden invalion of a petrifying Spirit, that Rain-Water may bring fuch Particles along with it. Since over a Bath in Hungary, that abounded with petrifying Particles, the Steams which were arrested by the building over it, were turned into stony Concretes; which may give us Reason to think, that petrifying Vapours raised

Dd 3

from the lower Parts of the Earth, meeting with rightly difposed Matter, may form Stones. without the help of Rain or Springs; which Conjecture may be favoured, by relatings that I have not only found an Earthy and Sulphureous Sediment in the bottom of Rain-water, but ! have observed that a distill'd Liquor being kept some time in a Vial well stopp'd, the Steams penetrated the Cork, and formed whitish Stirie, very flender and of a furprizing length. And that petrescent Springs are not always requisite, will appear, fince I have found transparent Stones in a dry Soil, which lay upon a Rock; and I have found that a folution of frony Stirie in Spirit of Verdigreafe, being poured upon Bolus Armenus, contained in a Glass, when the superfluous moisture was exhaled, several transparent and untinged Crystals appear'd, difperfed through that Red Earth. And the best petrify'd Wood that I know of, was taken up out of a Plot of fandy Ground, where there was not the least figns of a petrifying Spring. 'And tho' some Stones seem to grow as from a Root, yet these may easily be supposed to have been formed in certain Molds; and that after their formation, the Winds or Rains washed away the loofer Soil from their upper Parts. Befides it might be eafily flewn, that flony Coneretions might be produced by the mechanical action of the Air upon the flony Parts, that facceflively apply themselves to the Matter that first begins to coagulate; and began to be for--faken by that moisture that accompanied those Parts, and was necellary to their due Application to their casual Roots; in imitation of which eting

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of ch hich I have obtained from faline and stony Clations, dry Turfs prettily figured, and diaanous or White; as also slender Stiria that

femed to grow out of the folid Glass.

But further, sometime petrifying Particles my be so diluted with ordinary Water, as not to discover themselves 'till they have fit Bodies to work upon: For I have received transparent and petrify'd Cristals from a Lake in the Northof Ireland, which grew to the Rocks in the bottom, but had no ill effects on the Fish which fram in that Water; and it is easie to suppole, that whether Water which lies in the Civities of Rocks be impregnated with petriick Particles from Springs, Rain-water, or fubterraneal steams; I fay it is easie to conceive, how these, after an Exhalation of the superfluon moisture, may petrifie the adjacent Soil, and form different Stones, according to the particular Nature of the petrescent Liquors, and the disposition and structure of the Soil they inrade; in which Soil if any Heterogeneous Matter be lodged whether Vegetable, Animal, or Mineral Substances, they must needs be found in that petrify'd Soyl when broken up: Nor is it requifite that this Soyl should be all petrify'd at once; for it may be petrify'd gradually, as the Polition or porousness of the Body give advantage to the petrifying Body that works upon them; fo that from hence it appears, how medicinal Stones of different Colours, Confiftencies and Effects, may be formed, and feem entire Bodies. And I have a Stone by me which contains a perfectly shaped Serpent coiled up in it, but without a Head; which

Dd 4

appears to have been formed before the Stone in as much as in the upper and lower Parts of the Store, there are Cavities left, which together form one Cavity, of the fize and shape of the contained Body; and that the Serpent and the Stone about it, were petrify'd at several times, may be argued from the different Terture of the petrify'd Animal, it being a clearer kind of Stone than that of the Mold; and even that Part of the Mold it felf which is contiguous to the included Body is whitish, and abounds with shining grains or flakes, in both which respects it differs from the other Parts.

But to proceed, in those several places in which Stones are plentifully found, in times past pretrescent Liquors may have been, fince not only Earth-quakes, Inundations, finking of Grounds, but the incroaching of the Land on the Water, as well as fiery Eruptions, have been able to dry up Pools and Lakes, and to divert the course of Springs and Rivers, so as to leave not the least footsteps where they flowed before.

Another Argument which will favour the Prothesis already laid down, may be deduced from this, that by proper Menstruums Mineral Parts may be drawn from some of these Stones, fo a Solution of Blood-Stone turned an Infusion of Galls blackish, and so did a Load. Stone Emeri and Marchalites opened with corrolive Menstruums, And Lapis Calaminaris kept in Fusion with Copper, changes it yellow for a Golden colour, and makes it Brass; and adds to its specifick Gravity considerably.

and Ouick-filver is known to be distilled from Ore found in the Mines of Friuli. But as we before intimated, there are feveral Stones, which one their Virtues to a Mixture of Bodies specifally lighter than Crystal; which is evident, face not only Brimstone, but Bitumens, are specifically lighter, the proportion of Brimfone being as two to one, and that of Afgbalme s one and a little less than to I. even some Bodies specifically Lighter than Cryhal may owe their Virtues to Mineral Particles, face they may be mixed with Ingredients specifially Lighter than Crystal, which may compensate the Surplufage of theirs; for I have had a piece of blackish East-Indian Flint, and likewise an bylish one of the same colour, the one of which weighed as 2 to 1, and the other # 2 to 1, which is equal to the specifick Gravity of Crystal; so that the Blackish colour seemed to proceed from some Mineral fmonk that had pervaded it, which may give Is Reason to believe, that the matter of Meditinal Stones may be tinged with Mineral Vapours before it is hardened: And that several inbterraneal Bodies may be raised in the form of Vapours, will appear from what hath elfewhere been delivered; and that Quick-filver will, we are affored by the effects of Fumigations in the Lues Venerea; and that it may be incorporated with Stones, may be observed in some kinds of native Cinnabar. And I have found that not only artificial but natural Sal-Armoniack, may be raised in the form of Exhalations by the help of fire. And that Sal-Amoniack, Sulphur and Mercury, may be sublimed limed into a Gold like substance, appear from the Preparations of Aurum Musican and that the Earth abounds with Mineral Exhalations of various kinds, appears from what hath been elsewhere delivered; as well by a as several other Authors; and since the Earth abounds with so great a Number of Mineral, there is no question but some of them may be able to penetrate and tinge some indurated Stones; and that a small quantity of a Mineral may be sufficient to tinge a great quantity of a Stony substance, will appear from several

Experiments already delivered.

But to proceed to the last Argument to be alledged on this occasion, I shall add, that it appears that opacous Gems receive their Virtues from Mineral Particles, fince most of them confift of Mineral Bodies petrified. And the most of these Bodies differ little from artificial ones, we are not therefore to deny them Medicinal Virtues, fince several Medicinal and specifick Virtues are attributed to Chymical Preparations, and that artificial Bodies may be endewed with Medicinal Virtues, appears from Galen, who delivers the ashes of a Cray-Fish as an Antidote against the biting of a mad Dog: And even Treacle is esteemed not only as an Alexipharmick, but endewed with specifick Virtues, upon the account of its manifest as well as occult Qualities. And to what I have faid, I shall add, that several Stones of the same kind differ in the goodness of their Medicinal Qualities, as Lapis Nephriticus; and several of them have Virtues which seem to belong to other kinds, when they are impregnated

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neted with the like Exhalations; so that I have fends Blood-Stone which would stop Hemorningies when made use of without the Persons howledge, yet by its colour it seemed to be of mother kind of Stone.

But to the foregoing Particulars I shall add, the fubterraneal Exhalations may be fo poweful and penetrating, as to petrifie both Aniand Vegetable Substances, as appears from parifyed Skulls, Bones, and pieces of Wood; and that Vegetable substances may be hardened into Stones is evident, fince Lapis Lyncurius, a Stone near Naples, being rubbed and moistened, and then exposed to the Sun in a due feason, will yield Mushrooms fit to be eaten, so that the feminal Principles of Vegetables may be perifyed, without losing a power of exerting themselves when they find an opportunity: and thefe kind of Stones are fometimes found to be of an extraordinary bigness. And that other Earths, subject to be petrifyed, may be endewed with Medicinal Virtues appears, fince I knew a Clay-Pit in which a Bed of Clay yielded by distillation a Volatile and strong Salt, which was a good Cordial, and a great opening and Diaphoretick Medicine. And that fublimable Salts, Sulphurs and Bitumens, may be met with in the Bowels of the Earth and in the Bodies of Stones, I have found by their Chymical Examens. And that Metalline Parts may concur to the Composition of a Medicinal Stone, may appear from native Sulphur, (which is it felf a compound Body) besides a good proportion of Mineral Earth.

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CHAP. III.

Of the Atmospheres of Consistent Solids.

Of the Atmospheres of consistent Bodies.

The Art fluid Bodies, fuch as Wate, Wine, Urine, &c. emit Effluvia, is too evident to want proof; and that even confiftent and folid Bodies emit Effluvia, will appear from what follows, fince not only Leaves of Plants, but Ambergrease, &c. are manifely odoriferous. And not only Volatile Salts are sensibly diminished, by being exposed to the Air, but Camphire which is a tough tenacious Body. And even from the Electrical Qualities of Amber, hard Wax, &c. it appears that they emit corporeal Effluvia; which sensibly affect the Nostrils when violently rubbed.

And as further instances of the Effluvia of confistent Bodies, we may add, that not only Apples but Eggs lose of their weight in Winter, and so does Wood; for having caused a Cup to be made of it, and Counterpoised it, it grew fensibly and gradually lighter, so that tho' it wanted two drachms of two ounces, yet it lost forty grains of that weight in ten hours. And even Ice which weighed two ources in a frosty Night, lost ten grains of its for mer weight, tho' not in the least thawed. And it is known to those that deal amongst Lead and Tin, that those Bodies emit very hurtful Effluvia, and Cold-Share Iron hath been observed to smell so rank whilst red hot, that

that the Smith could scarce endure to work it; and not only Iron, but Brass and Copper,

when heated finell very unpleafantly.

And to these instances I shall add, that beides Load-Stones, black Marble, as well as other Stones, whilst a Polishing, will emit sensible Effects, which is evident by the smells they emit. And amongst other Bodies which convince us, that they emit sensible Effluvia by their smell, I shall enumerate those Conial Stones called Thunder-Stones, which upon attrition emit a Sulphureous smell; and so did Substance which much resembled a Marchaite: And I made a Mixture of a Metalline Body and a coagulated Mercury, which had considerable effects on the Eyes as well as other Parts, near which it was worn as an Appenfum. And Vitrum Saturni, made with a good quantity of Minium, is not devoid of Electricity; nor is Bras free from an offensive smell, when its Parts are put into a violent concussion by turn-

And amongst Electrical Bodies I have seen some of so close a Texture, and so hard, that they would strike fire, and Aqua Fortis it self would not work upon them, as Cornelians, Rock-Crystal, &c. And even so hard Bodies as Diamonds are found to be Electrical. And I have observed, that Concretions called Cugoli, made use of by Glass-men in the East-Indies emits a smell upon attrition; and so will a Cakulus Humanus; and Iron it self if held to a grinding Stone without the use of Water. And Marchasites likewise upon an attrition e-

mit a Sulphureous Odour.

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And even so fixed Bodies, as Regulus of timony, and its Glass, communicate to Liquor Emetick and Purgative Emanations; and Glassit self, which is fixed enough to endure the force of the Fire, upon Attrition, emit offensive Effluvia.

And the Heat of the Sun and Fire have to great a stroke in exciting the Atmospheres of Bodies exposed to them; that Amber being exposed to the former, and Glass to the latter.

they both became Electrical.

And I question not, but that if a great many Bodies, not yet tryed, were carefully weighed, they would appear sensibly to emit Effuvia; tho' the waste made by some Bodies is so small, as to be scarce discernable, if at all, as in Loadstones, Ambergrease, &c. Those requiring a long time to make their Consumption discernible, in which time we are not sure but the Weight themselves may have lost of their weight, as well as the Counterpoise, and consequently not be able to discover the loss those surface.

But there are several other, besides statical, ways of trying whether Bodies emit Essavia or not; and there are several peculiar ways requisite to cause them to emit them; as Glass, e.c. affect the Nostrils upon an Attrition. I had a Diamond, as well as a Ruby, which would be excited by a gentle heat in my Pocket, or only by strokeing my Finger over the former, the sometimes they would fail to be so easily or uniformly excited; and it is not a little strange, that upon the Tread of a Hare or Partridge, Essavia should be so long emitted, as to give a Scent to Dogs several Hours after.

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Constant Atmospheres which are only to edicover'd by particular Bodies; several or Substances, not yet taken notice of, may extensive, which by peculiar Methods may be discover'd.

CHAP. IV.

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Of the Strange Subtlety of Effluviums.

THE fubtlety of the Effluviums will be Octhe fub most aptly represented, by considering, thety of Ef-I. The strange extensibility of some Bodies, Puviani. whilf their Parts remain tangible. II. The Multitude of visible Corpuscles, that may be afforded by a small Portion of Matter. III. The smallness of the Pores, at which the Effluvia of some Bodies will get in. IV. The small Decrement of Bulk or Weight that a Body may faffer, by parting with great store of Effluvia And, V. The great quantity of Space that may be filled, as to Sense, by a small quantity of Matter, when rarify'd or dispersed.

And First, I have observed that a Grain of Silver Wire amounted to 27 Foot, or 324 Inches; and since half an English Inch may be divided into a 100 Parts by diagonal Lines, it must consist of 64800 true Metalline Parts, which may be well conceived to be made of Parts yet more minute. And I had a gilt Wire, an Ounce of which made a Wire 1000 paces long, allowing Five Foot to a Pace, and 720 Foot a-

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bove; and had this Wire been drawn out to an equal smallness with the Silver Wire, the Gold would have been divided to an indefinite number of Parts, being sufficient to cover the sperficial Area of so long a Wire. And I have known Silk to be drawn out of the Mouth of a Worm, which, tho' it weigh'd but two Grains

and a half, was 300 Yards long.

But to evince the great extensibility of Mat. ter, we took fix beaten Leaves of Gold, the fides of whose Squares were a Inches and a, which Number being reduced to a Decimal Fraction viz. 311, and multiplyed by it felf, affords for the Area of each, and this multiplyed by 6, the Number of the Leaves amounts to Glare Inches for the Area of the fix Leave of Gold; which weighed but I Gr. 1; fo that 4 Grains was extended to above so square Inches And if each of these Inches may, by Lines drawn from opposite Points, be divided each into 100 Parts, one Grain of Gold must be divided into 500000 little squares, discernable by a good Eye; and if an Inch were divided into 100 Parts, as I have one by me that is, then a Grain may be divided into 2000000 of iquares. Am to be fatisfy'd further of the extensibility of Gold, I enquired, and was told that 8 Grains of Gold would gild an Ounce of Silver Wite as fine as a Hair, and which would reach be twixt 90 and 100 Miles. But supposing the Wire to be as fine as that first mentioned, and that 8 Grains of Gold went to gild it; a fleath of Gold weighing but 8 Grains, may be extended fo as to reach 60 times as much (in weight) of Silver Wire as it covers; and confequently

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legain of that Wire being twenty seven foot less, the ounce of Gold would reach to misso foot i. e. 155; miles; and if this Gold Wire were cut into as small thongs or lists as publy it might be, it must reach to a stupen-

ious length.

But secondly, to shew into what a number f visible Corpuscles a Body may be divided. re put an ounce of Water into an Solipile. ad having placed it upon a Chafing-dish of Couls, we observed that Vapours streamed out be shove fixteen minutes; and confidering a few stermitting gults afterwards, and what drops Water were condensed in the top of it. I melfed, that had the whole been driven ont a Vapours they would have continued twenty minutes; N. B. to the Orifice of the Loliwe applied a long Tube twenty Inches and an Inch in Diameter, the remoter and being continued about fix Inches longer. m fo far expanded that its Diameter was four or five Inches; and by the help this Pipe we were able the' not actly to measure the Extension of the rarified Vapours. To this infance I might add the prodigious expansion of some Inflamable Bodies, when turned into aftual flame, as Spirit of Wine, &c. Which being burnt in a Glass Lamp, so contrived that the Surface of the Liquor was Still Circuhr, the waste made in ! of an hour was very fmil, tho' the Phylical Superficies of the Liquor must needs be successively rarified and expaded, and fiv away in streams; and if so litthe of this Liquor was able to afford matter for fame to long, the same bolk of a more compact

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Body may easily be supposed to be capable of being expanded to much greater Dimensions And to these instances I shall add, that half a grain of Gun-Powder being exploded under a Vessel, whose Basis was eight Inches and in Altitude twenty; and its figure fuch, that it was more Capacious than a Cone of that fire the exploded Gun-Powder was observed to fil the whole Cavity of the Vessel as to fense, and fuccessively issued out of the upper Orifice for half a quarter of an hour, fo that the Diameter of it being two Inches, many Myriads of visible Corpuscles, must be conceived to throng out in fo long a time as they crouded out one after another: But to make a kind of an estimate of the Expansion of this Substance we filled the Vessel full of Water, and found that the weight of it amounted to 320000 half grains: And if we suppose the specifick Gravity of the Gun-Powder to be as much again as that of Water, we my probably guess the fmoak to posses 500000 times the space that the Gun-Powder did. And as a further Argument of the great minuteness of small Parts of matter, I shall urge the smallness of Cheese mites; which being fo fmall as not to be difcernable to a naked Eye, but when they more must be made of extremely fine Parts, otherwife there would not be room enough for at Organical Body; and if an Organical Body fornished with all the Parts requisite for the Prefervation of Life be contained in fo small a compass, how minute must they be at the first, fince the Eggs out of which they are formed bear bu a fmall proportion to them, when perfectly formed.

med, and even comparative Observations tell is, that a Mite being ten days a hatching, the Rudiments of its Body at the first must bear hat a small proportion to the bulk of that small Egg; and to this I shall add, that the these Creatures be so very small, yet I have been able to discern single hairs growing upon

their Legs.

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Another instance of the Extension of matter minutely div ded is this, viz. We diffolved a grain of filings of Copper in Spirit of Sal-Armoniack; pouring the Solution into a tall Cylinder four Inches in Diameter, and fuccellively filling it four times with distilled Water, still pouring it off into a Conical Glass; which being done, and the weight of the Glass Cylinder deducted from the Joint weight of the Liquor contained in it, we found that one grain of Copper was able to give a Tincture to 18714 times its weight of Water, tho' its specifick Gravity is not half so much as that of fine Gold: and if we estimate the proportion not by weight but the bulk of these Bodies, the bolk of Water to Copper being as nine to one, the aforementioned number multiplyed by nine will give us the proportion betwixt the tinged and tinging the Body, so that one grain of Copper gives a colour to 255806 parts of Limpid Water, and by profecuting this Experiment further, I found that it was able to give a manifest Tincture to above 385200, and a faint but discernable one to above 113620 times its bulk of Water.

To shew that the Essuvia of Bodies may enter in at very small Pores, I shall intimate the effects of Cantbarides held in the hands of some Persons; and on the Neck of my own Bladder when applyed outwardly to my Neck. And not only Scaliger tells us of Spiders in Gascony, whose Virulent Poyson would penetrate the Shooes of those that trod upon them, but Piso speaking of a Fish called Amoreatim, and by the Portugals Peize sola, he says, Que mira sane Essicacia non solum Manum vel levissimo attactu, sed & pedem, licet optime calceatum, Piscatoris incaute Pisciculum conterentu, Paralysi & stupore assici, instar Torpedinis Europea, sed Minus durabili, Lib. 5. Cap. 14.

And to shew that some Emanations, even of folid Bodies, may be fubtle enough to get through the Pores even of the closest Bodies; I shall add, that a needle being Hermetically fealed up in a Glass Tube, and that laid upon Water, a Load-Stone would cause the Needle to leap up in it, and by the help of the Load-Stone, I could lead the Tube from one part of the Surface of the Water to another, as I moved the Load-Stone. And to shew that the Magnetical Effluvia of the Earth, may penetrate fo close and compact a Body as Glass, I shall add, that a Cylindrical piece of Iron being fealed up in a Glass Cylinder, and held in a Perpendicular Posture, it acquired such Magnetical Virtues, as to become a North Pole, and according to Magnetical Laws to drive & way the North Point of a Needle; but being inverted, and held under the Point of a Needle,

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Needle, it became a South Pole, and attracted

Another Proof of the great subtlety of Effluviews, may be taken from the small decrease of Weight, by parting with store of such Emamtions; as Vitrum Antimonii, Crocus Metalloand Quick-filver, the two first of which give a Vomitive Virtue to a vast quantity of Wine, without growing fenfibly lighter, and fo Quick-filver impregnates Water with a Virtue of killing Worms. And a piece of Ambergreafe which weighed about 100 or 120 Grains, being suspended three days in the open Air, loft not sensibly of its Weight, notwithfranding the quantity of odoriferous Steams it must have parted with in that time. Ala Fætida, in about fix Days, loft about half a quarter of a Grain; one Ounce of Nutmegs, in fix Days, lost & Grains; and an Ounce of Cloves, 7 grains 1. And tho' Loadstones emit Effevia without a fenfible loss of weight, yet I faspect, that as these Magnetical Particles fly out of one Pole, they enter in at the other, and fo make the Pores of the Load-stone their confant Thorow-fares. To these Instances I shall add, that a Grain of Copper being dissolved in aspoonful of a Menstruum, and that put into a Glas-Lamp, the Metal tinged the Flame, which continued half an Hour and fix Minutes; fo that supposing the Flame to have streamed through a Cylindrical Pipe fo long, that small parcel of Metal must be divided into a valt Number of small Parts; for Water, which ran through a Cylinder, whose Diameter was but half as great as that of the Flame, amounted to

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above Nine Gallons, or Seventy two Pounds. The last Particular I shall insist upon to few the strauge subtlety of Effluviums, is the great quantity of space a small parcel of Matter may be extended to, and as to Sense possess it; this we may be enabled to guess at, by confe dering how long a Dog will diftinguish the Scent of Partridges, Hares, &c. after they have left the Place, and will almost give one sufficient grounds to guess how long the Animal hath been gone from thence before. And I am told that a Blood-hound will not only perceive the Scent of a Man that hath gone over a piece of Ground several Hours before, but that the scent of a Deer will continue upon the Ground from one Day to the next. And if we consider that the eighth part of a Grain, can scarce be soppos'd to be left on the Ground where fuch an Animal hath stood, and likewise at what distance it may be scented, and how long that feent continues, it will be fufficient to convince us of the extraordinary minuteness of those Parts of Animals, which were rendered more apt to be diffipated in Effluviums, by their having been first strained through the Pores of their Bodies. Nor is it less remarkable, that Birds, especially Crows, are able to discover the smell of Gun-powder at a confiderable diftance; and

vations, as well as the Relations of others. And on this occasion I shall add, That Julius Palmarius, in his Tract de Morbis Contagiofs, observes, that Horses, Beeves, Sheep, and other Animals, have grown mad by eating the Straw that mad Swine have lain on; which may give

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But to profecute the chief aim of our Difcourse, I shall add, That fince Corpuscles that re too minute to be visible, may affect an Oren of Sense; it is not improbable, but that there may be a great many which may be fo fine as not to affect any one of our Senses, and confequently may continue an Atmosphere much longer than we are able to take notice of. So Forestus tells us of a Pestilential Contagion that was a long time preserved in a Cobweb. And Alexander Benedictus tells us of a Flock-Bed, which, when feveral Years after the Plague, it was beaten, it presently infected the By-standers. And Sennertus tells us that in Uratifiavia, in fix Months, fix Thousand Men dved of the Plague; and that from that time, the Infection was preserved in a Linnen Cloth, and being displayed in another Place, 13 Years after, it infected that Place likewise. And Trincavella tells us, that an Infection was preserved a long time in Ropes, by which dead Persons were let down into their Graves. And an Infince of the like kind we are furnished with by Dienerbroeck, who acquaints us that an Apothecary of his, turning over some Straw, upon which a Bed had lain which held an infected Person, the Steams immediately caused Blisters upon his Legs, and a Carbuncle which was a Forthight in healing. And to conclude this Chapter, I hall add, that I have a pair of Spanish perfum'd Gloves, which have continu'd their scent about Thirty Years, tho' they were not io much as shut up in a Box. Ee 4 CHAP.

CHAP. V.

Of the great Efficacy of Effluviums.

O the great Efficacy of Efficients THO' Particles of Matter which are minute, are looked upon to be unable to have any considerable Effects; yet I shall endeavour to shew, that they may have considerable Effects. I. Upon the account of their great Number. II. Their Penetrating Nature. III. The Celerity and Modification of their Motions. IV. The congruity of their Bulk and Shapes to the Pores of the Body they are to act upon. V. The Motion of one Part of a Body which they cause to act upon theother. IV. Their Aptitude to cause themselves to be assisted by more Catholick Agents; tho' they may perform several things considerable upon these Accounts; yet sometimes two or three, or more, concur to the producing of the same effect.

And, First, From what hath been deliver'd in the fore-going Chapter, it appears that the Effluvia of Bodies are very minute, and confequently it will follow, they must be numerous; and that a great number of small Agents, when they act per Modum unius, may have considerable Effects, is evident; fince inundations of whole Countries may be caused by Showers of Rain when drops fall in multitudes; and aggregates of small Sands, not only bound the Scas, but form Banks, upon which the greatest Ships are sometimes split; and tho' the Effects of a fingle Grain of Gun-powder is immaterial, yet prodigious things may be done by a great number of them; and the Vapours are made up of very fmail Particles, which feem to be in-

dive,

dive, yet in moist Weather, they cause Salts to melt, wood to swell, and Viol-strings, if they be stretched too much, to break. And it hath been observed, that the invisible Steams of a newly whited Room are so offensive, that People who slept in such Places, have been found dead in the Morning, being suffocated with those sumes; and tho' the Vapors which can issue out of such Bodies at once, cannot be sufficient to produce such Effects, yet if we consider that they continually succeed each other, as Wind out of an Lolipile; their Number and Minuteness may enable them to cause considerable Effects.

And that the fubtlety and penetrating Nature of Effluvia, contribute much to their Effects; appears, fince good Aqua-fortis and Spirit of Nitre are fo penetrating, as in a little time to pervade the Corks with which the Bottle they are contain'd in are stopp'd, and to reduce them to a Pap. And running Mercury hath been found in the Heads of those that have been too much exposed to Mercureal Fumes. And in the Laboratories of Chymists, the Steams of Sulphur, Antimony, Arfnick, &c. make those ftagger that less cautiously unlute the Vessels in which they have been sublimed or distilled. which Instances may be added, the infectious Steams in the Plague which suddenly infect the internal Parts; and likewise the sudden Effects of a Torpedo. And I prepar'd a Sal-Armoniac fo powerful, that it restored a faculty of Smelling to one that had lost it a considerable time; which Virtues it had, belides those more common ones, of affecting the Eyes, Mouth and Stomach. And on this occasion, I shall subjoin, that the Steams of Water assisted by warmth, are sufficient to dissolve hard and solid Bodies, so that by Philosophical Calcination, solid pieces of Harts-horn are made so friable, as to be easily reduced to Powder, only by being hung over the Steams of distill'd Waters: And to this I shall add, that under several Places in the Torrid Zone, the Dew is so penetrating, that it causes Knives to rust in their Sheaths, and Swords in their Scabbards, and even Watches in their Cases: And in England I have known hard Bodies become friable by the infinuation of Vapors into their Pores; and I have known solid and Mineral Bodies burst, by the powerful infi-

nuation of Effluviums.

And that the Celerity of the Motion of minute Bodies, may contribute much to their Effects, appears from the Effects of Gun-powder, Aurum Fulminans, Flames, Whirl-Winds, and Winds. And I have made it appear, that those Odoriferous Steams which swim in the Air, and affect our Nostrils, are in too languid a Motion, 'till enabled to affect the Senfory more powerfully, by running through the Nostrils in a Stream; and I have likewise made it appear, that Setting-Dogs, &c. will be much more affected with a Scent, when the Wind Blows from the scent towards their Nostrils, than when it comes the contrary Way; the current of the Wind causing the Odoriferous Steams to affect the Senfory more briskly. And Electrical Bodies exert that Faculty more strongly after Attrition, the emission of their Electrical Steams being by that means excited: And the Learned Faber hath observed, that if a Hare was fuspended



mended near an Electrick when the Effluviums sere too briskly agitated, it would not be atmiled, but driven away from it. And I know certain fubstance made by distillation, whose fnell in the Cold is very inoffenfive, but when it is warm, it emits Steams more strong and penetrating than Sal Armoniac. And I have mown folid Substances stink egregiously when excited to emit their Effluvia by Attrition. And scelerity of motion contributes to the Effects of fabtile Bodies, fo does the different modificaton of that Motion; for as a Stick or a Javelin, but different Effects when they fly with one ad first from what they have when they twirled round with a certain Rotation; and the founds of Musical Instruments are different, according whe different determination of their Motion, And the impressions made upon the ambient Air.

And that, besides what we have already tahe notice of, the congruity or incongruity of the Particles of Matter, in reference to the Bodis they are to work upon, contribute much to their Effects, appears from the Effects of Lightning: For I have feen two tall drinking Glafis to alter'd in their shape by the influence of Lightning, that the one was a little widened near the bottom, and the other so far bent, that it flood awry; the Beams of Lightning being able, in the twinkling of an Eye, to melt Glass; the in Glass Furnaces the Fire is sometime before it can produce that Effect. And I once faw Lead melted by Lightning, which left the Glass unaffected; and likewise other combustible stuff that was near it; and tho' it left these Things nntouched

untouched, yet it threw down part of a Wall, belonging to the House, by passing through it. And it is a common Observation, that Thunder, either by giving a determinate Concussion to the Air, or transmitting some Essential, turns Beer sowre; but having sealed some up in Glasses Hermetically, the Thunder was not able to affect the Liquor contained in them; and it is a common practice to prevent Beer from sowring upon Storms of Thunder, to place Chasing-Dishes of Coals under the Barrels, the sulphureous steams, being by that means so alter'd, as either not to be able to penetrate the Barrel,

or not able to alter the Liquor.

Another Way, by which considerable Effects are caused by Effluvia, is by exciting such a Motion in the Body they work upon, as to make one part of it act upon another. Instances of which may be brought from inanimate Bodies, as well as living ones, since some vigorous Loadstones destroy the attractive Virtues of an Excited Needle in a trice; or give it a Virticity quite contrary to the former, without touching it; and these magnetical Emissions which must needs be very minute, since they are subtle enough to penetrate Glass, are able to take up a considerable weight of Iron; so that I have seen a light one which would take up Eighty times its weight.

But the chief Instances I shall now insist on, are those wrought upon Animals; for it is evident, that our Organs of smelling are chiefly affected by such minute Particles of Matter as the finest Odours consist of; nor do they always affect us as Odours, since violent smells,

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whether stinking or fweet, are able to caufe very troublefome Head-achs. And the fmell of a very pleafing Perfume may produce in a homane Body, which before was well and ftrong, both faintness, swoons, loss of sensible Respintion Intumescence of the Abdomen, seeming Epilepsies, Convulsive motions of the Limbs, Oc. And I had a Sal-Armoniack which would in a little time remove Hysterick fits. and recover People, who by the by-standers were judged to fall down in Epileptical fits. which sudden effects seem to depend on the consent of the Genus Nervosum. But, besides these effects of Odorous Bodies upon Women, I know a Man of a strong Body and a fanguine Constitution, who will be put into a violent Head-ach by the fmell of Musk; and another to whom the smell of Roses was as offensive; and I know a Lady, who would prefently from at the smell of Roses, if they were not speedily removed. And as these slight smells have proved offensive, so it is not much less considerable that the smell of Sal-Armoniack cures the Head-ach. Besides, the aforementioned effects of Effluvia, it is observed, that Women have miscarryed upon the stink of a Candle carelesty extinguished. And I not only know a Gentleman who will Vomit upon the smell of Coffee, but a Physician who will Vomit and Purge, if he does but smell at EleGuarium Lenitivum: And I know another whom the smell of the grease which is about the wheels of a Hackney-Coach will make fick, and cause to Vomit, if it does but pass by him. And And not only smoak is offensive to the Eyes and Lungs; but the invisible steams of Sal-Armoniack. And besides, the aforementioned instances of the effects of Effluvia upon the Genus Nervosum, I shall add one of their Effects on the humours; for I know an Apothecary who upon the smell of Roses, hath such a Colliquation of Humours in his Head, that they set him a coughing, make him run at the Nose, and give him a fore Throat, and also by an affluence of humours make his Eyes sore.

And as Effluvia may be enabled to perform feveral things on the account of the structure of particular Bodies; so they may effect several things, by Virtue of the Fabrick and Laws of the Universe, for Bodies by Effluvia may be rendered sit to be wrought on by Light Magnets, the Atmosphere, Gravity, or some other Catholick Agent of the Universe. And to what instances have already been given of Bodies working upon others placed at a distance, I might add the effects of contiguous Bodies, as Bloodstones, Cornelians, Nephritick Sones, Lapis Malacensis, and some Amulets, and other solid Substances externally applyed by Physicians, as Cantharides, &c.

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CHAP. VI.

Of the determinate Nature of Effluviums.

THO' Aristotle and his followers, have on- of the dely diftinguished the Exhalations of this terminate Globe into those which he calls fumes, and Effuriums. which rifing from the Earth, he terms hot and dry; and those Vapours which rise from the Water, which he calls hot and moift, in these words, "Est pag druis @ will outes, ingir x synd; yet besides these slight differences, since the Earth contains several Bodies, which have each of them diffinct Atmosphere, we may probably conceive them to have their distinct and determinate natures; and even in fluid Bodies Heterogeneous Parts may fwim, which notwithstanding their fluidity may retain their determinate Nature, fince Rock-Allom and Salt-Petre being dissolved together in Water, upon a gentle Evaporation, will each of them hoot into Crystals of their respective and determinate Natures.

And that Effluvia retain their determinate natures, tho' fo fmall as to swim in the Air or Water, appears, fince upon their Re-union they are of the same Nature with the Body that emitted them; as Water raised in Vapours condenses again into drops of Water: And Quick-Silver in Distillation, if it be raised with a convenient fire, will almost all be found in the Receiver, in the form of running Mercury: And if when Chymilts are either making an Amalgama, or forcing the Mercury away



away from it by the fire; they hold a piece of Gold in their Months, it will be white as if it were Silvered over. And not only Sulphur, but Camphire sublimed in close Vessels. unites into a Substance of the same Nature as the other, and tho' a Body be compounded of a Metal and another Mineral, and two or three Salts; yet upon the Purification of the Mixture from its groffer Parts, if the remaining and finer Parts be minute enough and finely shaped, the whole Liquor will ascend; and yet in the Receiver altogether recover its pristine form of a transparent fluid, compofed of differing Saline and Mineral Parts, which is evident in the Diftillation of Butter or Oyl of Antimony very well rectify'd; for this Liquor will pass into the Receiver diaphanous and fluid, tho', besides the Particles of the sublimate, it abounds with Antimonial Particles, carried over and kept invisible by the corroding Salt : And I am told, that Tin will retain its own Nature in the form of fumes or flowers, which is evident, fince that white fublimate which is gathered above the Furnaces where the Ore is brought to Fufion being melted down, will yield store of Tin.

And besides these ways, the determinate natures of Effluviums, may be distinguished by their sensible Qualities, since the Exhalations which rise from several Bodies produced by Art, appear to be of different colours; the no external Heat is employed to raise them; for the sumes of Spirit of Nitre well rectify'd, when cold and stopped up, appear in the Vial

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Val to be of a redish colour; and when the Velet is unftopped they will ascend in the form of a redish, or Orange tawny Smoak. And Spirit of Salt or Oyl, will when exposed to the open Air, ascend in the form of a white Smoak; and fo will a Volatil Tincture of Sulphur made with Quick-lime; and both this and that of Salt-Petre do by their Ismell, s well as operation, discover of what Nature they are; and I have observed, that the effentialogl of Wormwood, being drawn off in a Copper Alembick Tinned, was not only green, but retained that colour when rectify'd in a Glass-Vessel; and tho' these essential Oyls be but the condensed Effluvia of Vegetables, yet they retain the genuine taste of the Bodes from whence they were drawn. And ox only Wormwood but Amber may commnicate their taste, by Effluvia raised without the help of Heat; for Wormwood having been kept in a close Room, not only affected the Noftrils strongly, but the Tongue with a bitter tafte, and Amber kept in Spirit of Wine impregnated it sufficiently to give it a genuine tife, as well as fmell; and that most essential Oyls retain their genuine Odours is very evident.

And that the Effluvia of Bodies may affect even the Touch of Animals, may not only be argued from the effects perceived by some People upon changes of Weather, but by that memorable passage related by Diemerbroeck, who after he was cured of the Plague, it left such a change in some Parts of his Body, that he says, Ab illo periculo ad contagiosos mihi ap-

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propinquanti in emunctoriis successit dolor, vix fallax Pestis indicium. To which I shall add that I knew one who could hear very for whispers when ill of a Feaver, tho' the found and healthful standers by could not; and I was told by a Lady, that she could tell by her fmell, whether one that came to visit her had been in any place where the Ground was covered with Snow. And I knew a Gentleman, whose Eyes were so tender during a Diftenper he had in them, that he could discern and diftinguish colours in the dark. And I am told. that a Blood-Hound found out a Man barely by fcent, tho' he had passed through a Market Town, and feveral Crouds of People. And further instances may be brought from Observations made on Blood-Hounds, some of which will scent a Deer twenty four hours after. And a Gentleman told me, that he knew when his Dogs were in pursuit of a Fox or a Hare. because they ran with their Noses nearer the Ground after the latter, the fcent of it not being fo strong. And I prepared a Body of a Vegetable Substance, which, tho' actually cold, would impart its colour to a Metalline Plate; tho' separated from it by the interposition of a piece of Paper,

But perhaps it may be Objected by fome, that these Effluviums may be altered by uniting with each other in the Air. To which it may be answered. That they may nevertheless reserve their determinate natures, tho' they act conjointly or so near it, that their distinct Operations cannot be perceived; as when two ftrings of a Musical Instrument are struck at the

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ome time, they both of them feem to make only one Impression upon the Ear. And if Spirit of Nitre be dropped into Oyl of Tartar m deliquium, upon an Evaporation of the fuperfluous moisture, the Acid and Alkalious Particles will form Nitrous Concretions, whose afte will be different from that of either of the femarate Ingredients: And fo if an equal proportion of Sal-Armoniack, be added to a strong foliation of Pot-ashes or Salt of Tartar, a shal urinous Spirit will come over in Distilbition; and also a Caput Mortuum, which is almost wholly a compounded Salt, differing mough from either of the Ingredients, especially the Alkalizate, in taste and other Onaliin. And to these Instances I shall add, that fereral flowers being aptly mixed in a Nofegrand held at a distance they make a confused and joynt impression upon the Organ of smelling; and fo do Perfume made up of feveral inpredients; and Spirit of fermented Urine, and of Wine being well dephlegmed, will incorponte like Wine and Water, without affording the least dry Sediment; but if in a convenient Veffel, they be exposed to a moderate Heat. the ascending fumes will adhere to the upper part of the Glass, in the form of a white but leader Sublimate, different from either of the Liquors not only in confiftence but tafte and feell. And if Spirit of Salt and Nitre, be devated by Distillation in the form of fumes, the condensed Liquor will dissolve Gold, tho' wither Spirit of Nitre nor of Salt would do And to demonstrate the Coalition of iteams the Air, I shall add, that having filled two Ff2 Vials. Vials, the one with Spirit of Salt, and theother with Spirit of Sal-Armoniack well rectify'd the ascending fumes which before were invisible, working one upon another in the Air, formed visible steams, which appeared like Smoak, but when they were removed a greater distance from each other, the separate and invisible steams were no longer discernable. And one thing relating to this Experiment which was remarkable was, that a drop of Spirit of Salt hanging at the end of a Glass stick, being held over the Orifice of a Vial with a long Neck the ascending Vapours of Sal-Armoniack would form a Smoak, which would be visible till it was a quarter of a yard above the Glass; but if the drop was held within the Neck of the Vial, the aforementioned fumes would fall into the Ball of the Glass, like a stream of Liquor, and spread it felf like a mist upon the Surface of the Sal-Armoniack, Which Experiment may help us to account for the fudden Invalion of Meteors and Clouds, especially in reference to the coming in or ceasing of several Epidemical diseases; and more particularly the Plague, which seems to depend on the Occult temper, and alterations of the Air, differently impregnated with fubterrane al Effluvia.

An Instance of which is related by Diema-broeck, who tells us of a Plague occasion'd by washing of foul Linnen with Soap, the Fumes of the Smoak uniting with other Effluvia in the Air, causing that Effect; to which might be added, what is observed about the ceasing of the Plague at Grand Cayro in Egypt, but enough of

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that having been already delivered in another Place; I shall add here, that I have made a thin upon a Body by the invisible steams and Effavoia of another cold Body; I altered the Colour of that Stain by the invisible and cold steams of a Third.

And to countenance my Conjecture of the Canse of Meteors, besides what hath been said of subterraneal Effluvia in another Place, I hall add the following Citation from Agricoh; who having mention'd, out of Ancient Hiforians, the raining of White and Red Licors, fabjoins. Ut autem majorem fidem babeami Analium monumentis facit res, res illa decetta, que Patrium memoria in Suevia acciit; Aer enim ille stillavit guttas, quæ lineas vehe crucibus rubris, quasi sanguineis imbuebant. And it will not be thought strange that subtermeal Salts, Bitumens and Sulphurs, may be nifed into the Air, if so fixed a Body as common Earth may, which the newly cited Author telifies. And that the odoriferous Particles d Plants referve their determinate Nature much longer than we are wont to imagine, appear; fince one drop of Oyl of Cinminon, gave not only a taste to 14000 times is Bulk of Water, but withal, diffused a great number of odoriferous Particles through the ambient Air.

The Last way we shall mention to evince the determinate Nature of Effluviums, is from their Essential on other Bodies. As the stupesying Essential of the Fish Amoreatim mentioned by Pish. The effects of Opium and Hypnoticks upon a Boy, who whilst he was distilling them, cast F f 3 him

him into a fleep. And the Root and Juice of Mandragora is faid to cast those that take it into a deep Sopor like a Lethargy; and Levinus Lemnius tells us, that the Apples of the fame Plant being laid in his Study, made him fo fleepy, that he could scarce recover himselt : Aureleas tells us, that the Poison of a Mad Dog hath been convey'd to one in the form of Effluzia; and Calius Aurelianus acquaints us. That some have become mad by being wounded only by the Claws of a mad Dog; and that one fell ino an Hydrophobia, folo odore ex rabido cane attracto. And Matthiolus tells us of one who was poisoned only by putting his Hand into the Mouth of the mad Dog, without being bit; and to this I shall add, that Sennertus relates, that a Painter having opened a Box, in which Realgar had been contained, the Fumes being fauffed up his Nostrils, presently caused a giddiness in his Head, and fainting Fits.

To these Instances I shall add, That several have been purged by the smell of Black Hellebore; and as Sennertus witnesses by the Odor of Coloquintida; and there are several other Things which purge when only externally applyed: And it is attested by approved Writers, that the Shadow of a Wallnut Tree, with the Leaves on it, is very hurtful to the Head. And it is not only observed, That Birds will not so much as light upon those Poysonous Trees in the West Indies, called the Manchinello-Tree; and it is looked upon as safe for Men to eat of Fruit sound in a strange Country, if it appears that the Birds have been pecking at them before. And Nico-

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in Florentinus tells us of one, who drawing inm his Nostrils the Smoak of a burnt Spider,
he was much disordered, and fell into a fainting fit, and was much disordered about the
Heart, his Pulse being likewise weak; tho'
after he was cur'd by a mixture of Treacle,
Damosc. and the Powder of Zedoary. And
I saw a Berry called Maccu-buy in Ireland,
which being pounded in a Mortar, caused the
Head and Face of one that stood hard by, to
smell enormously. And,

To what hath been delivered of the determinate Nature of Effluviums, I shall add, that Amber, Musk, Civet, &c. will communicate a Perfume to Gloves, tho at a distance off them; and contagious Distempers, as the Plague, Small-Pox, or Measles, may not only be communicated by immediate Contact, but by steams which issue from the Body of the sick

Person.

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But to conclude this Chapter, I shall add the following Experiment, Viz. Having thut up an Ounce of a Volatile Tincture of Sulphur in a Vial, capable of holding at least twice as much, and having placed a Paper at some distance, and unftopped the Vial, the spreading Fumes presently caused what was writ with invisible int to become legible. And so would several Letters writ with a Solution of Sublimate in Water, fome of them being more, and others less Black, according to their distances from the imoaking Liquor and other Circumstances: And when the Paper thus writ upon, was held over the Orifice of the Vial, tho' the Letters were on the upper fide, yet in a quar-FfA

ter of an Hour, they became legible; and a in some cases, this smoaking Liquor, with a folution of Sublimate, will produce a Precipitate of a Silver Colour, fo in some of the Colourless Ink we found the like Colour. And I have performed the like with a couple of Liquors, wherein was neither Sulphur nor Sal-A. moniac, nor Sublimate, And as a farther Proof of the great penetrancy of Effluviums, I shall add, that having a Paper which was writ on with this invisible Ink, betwixt fix folds of Paper, these Fumes penetrated it in Ten Minutes, and turned the Ink Black; and another piece of the same Inked Paper, being placed betwixt the Leaves of a Book, the steams penetrated Twelve in three Minutes, and turned the Ink blackish.

CHAP. VII.

Of the Porousness of solid Bodies.

of the Poi THAT even folid Bodies are not destirousness of tute of Pores, I am inclined to believe, because most folid Bodies, as Gems, or.
have once been in fluid Forms; and since Fluids are generally made up of Particles of a
determinate size and shape, they must needs
leave some Pores betwixt them.

Another Reason why I am inclined to think most Bodies porous, is their specific gravity; which would not vary were the Parts of them equally compressed and closed

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together, but fince Copper is heavier than from and Gold, as nineteen to one to its proportion of Water, and Copper only as nine to one, it must follow, that the matter of Iron possesses as much space again as Gold and more. And the hardness is urged by some as an Argument of their Substance being condensed, yet I have elsewhere shewn, that the Diamonds are the hardest Bodies, they are far from being the heaviest, which is the only sign whether they be condensed or not.

And fince Metals themselves are made up of a Coalition of several Parts, it is impossible they should be so Physically adapted, as totally implere spatium; since were Cubes made of Marble, it is impossible they should be so exactly Polished as every where to be contiguous, since the Bodies employed to Polish them are observed to make little surrows upon them, and consequently leave little Inter-

vals or Pores.

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And that Wood is not void of Pores will appear, fince Quick-filver hath been observed to penetrate the sides of a hollow Cylindrical piece of Wood, and when the Air was drawn out of my Pneumatical Instrument, the external pressed so hard upon the outside of a Board which covered it, that tho' it was of strong Wood, and of a considerable thickness, yet it made its way into the Cavity of the Receiver, through the Pores of the Wood; and to these Instances I shall add, that the sumes of a Smoaking Liquor tinged a Copper Halfpenny, through a broad thin shaving of Deal, tho' we could not discover any sensible Perforation:

foration; and the same Experiment being again repeated with two, and a third with three shavings, they tinged the Copper Half-penny, tho' not, in fo little time, nor quite fo confoi-

cuously. And,

That baked Clay is not void of Pores is evident, fince Ovl will foak through ftrong and well baked Earthen Vessels, and so will Solutions of Nitre and some other Salts; and very few except Haffian Crucibles will keep Salt of Tartar long in Fusion without being penetrated by them. And Vitriol and Salt-Petre have been observed to lose much of their weight when distilled in Earthen the fubtle and spirituous Parts flying away through their Pores. And I am told, that those Juggs that are made of Earth, hardened fufficiently to strike fire with a good Stell, have their Pores pervaded by the most subtle Parts of Spirituous Liquors; and it hath been found by Experience, that Spirituous Cyder hath fweat through the fides of Stone Bottles; which manifested it felf by its taste: And I have found, that Silver dissolved and turned into a horny Substance with Aqua Fortis, being kept in Fusion in an Hassian Crucible, several Particles penetrated the Pores of it, and appeared on the outfide.

And to prove that natural Stones are porous, I shall intimate, that I had a Vessel made of Stone fent from the West-Indies, through whose Pores Water would sweat; and if the Transparency or Opacity of Bodies proceeds from a rectitude or crookedness of Pores, which makes them fit or unfit to transmit the Rays

d Light. Oculus Mundi will be an Argument of the Porofity of Stones; fince whilft it is dry and in the Air it is opacous, but when it hath hin a while in the Water it becomes transperent like Amber, but foon loses its Diaphaneity when exposed to the Air again, and so Paper wet with Water becomes more transparent, but loses of that Transparency when dryed again; and to favour this explication, I shall add that an Oculus Mundi having been weighed after it was taken out of the Water, it appeared to be heavier than before. And fince several Stones, as Granates, Emeri, &c. contain Mineral Parts, it is impossible they should be exactly contiguous without leaving fome Pores betwixt them and the Parts of the Stone; and for the like Reason all artificial Gems made by Fusion, and tinged with Hetcrogeneons Pigments must be supposed to be furnihed with Pores; and fince natural Gems are made up of Stony Ingredients, and Mineral Parts, for the same Reason we must suppose them to be furnished with Pores likewise; and the like may be concluded in reference to all Heterogeneous and compound Substances; as Marcaintes, Load-Stones, &c. And that white Marble is not void of pores may be argued not only from its easie Solution by Aqua Foris, Spirit of Salt, &c. but from its aptness to be tinged with Vapours, that are not fretting, so that red and other colours may be soaked into it as Oyl is into Wood. And having cemented some clear Fragments of native Cry-Ital with a composition of some Volatile Minerals, together with a Salt or two, and hav-

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ing suffered the Crucibles to cool leisurely, several of the Fragments were stained here and there with different colours, some more and others less dull; but whether the Tincture these pieces of Crystal received proceeded from some of the sinest of the Mineral Parts, imbibed into the Stone when slawed with too much haste; and whether upon cooling those slaws did not grow too close to be discernable to the Eye, I shall not determine, but shall add, that it hath been observed, that Rubies when Polished upon the Wheel, and very hot, have seemed full of cracks, which upon their cool-

ing wholly disappeared.

And that Metals themselves are porous may be argued, from their aptness to be dissolved in proper Menstruums. And especially by laying Sulphur and thin Plates of Copper SSS, in a Crucible upon which another was luted, to keep the Sulphur from taking fire; for having kept them thus about three hours in a heat, which was fufficient to melt the Sulphur, but not the Metal, when it was taken away from the fire and cooled, we found, that the Sulphur had so penetrated the Body of the Copper as to turn most of it into a brittle Substance, which would crumble away with ones fingers, being altered not only in Texture but colour, some being of a dirty dark colour, others of a violet, and many of the Plates when they were broken, feemed to have been divided into two Plates, and to have a manifest distance betwixt them, and we could likwife difcern the fibers of the Metal, extend themselves from one side of the Copper Plates to the other. And that the Sulphur

ther penetrated into the Pores of the Copper-Plates might not only be discerned by their ocrease of weight, and bulk, but a Blue Flame which would discover it self when they were laid upon quick Coles. And by a like Experiment, we found that the Body of Silver, Tin, and Lead, might be penetrated. And not only Sulphur, but Arfnick will penetrate thus into the Body of Metals. And I know a Pigment which tinged the Body of Copper, so as to give it the Colour of Gold: And Perfumes do not only continue long in the Pores of Glasses; but I am told by one, that he had a Watch, whose Metalline Case was richly perfumed. And I remember I made a Substance much like Gold, which retained feveral Mercurial Particles in it, and being cast into a Ring, it was observed to have manifest Effects on the Eyes of several Persons. And I am told that the Off-spring of the Granadine Moors, had an Art of curiously perfuming the Weapons they forged; and the same Nobleman who told me this, acquainted me that he had a Fowlingpiece whose Barrel was perfumed, but its smell was much fainter after it had been scoured.

And, Lastly, To shew that even common Glass is not void of Pores, I shall reduce what I have to say, and comprise it under the following Propositions.

PROP. I.

It's very probable, that Glass may be pierced into, at some distance, even by visible and tangible Bodies.

And besides the Arguments already offered to evince the porofity of Bodies, I shall add, That a certain Spirit of Salt being kept in a Glass in a cool Place, it corroded some Parts fo much as to leave them as thin as a piece of Paper; and lined with a white Substance, which seemed to be some of the Alkali of the Glass and Sand corroded by the Saline Spirits of the Menstruum, and coagulated with them into this odd kind of concrete; and this wrought no higher than the Liquor contained in the Glass. And besides this, I had another Vial corroded by a distilled Liquor of Vitriol, which contained more Phlegm than Oyl; and to this Relation I shall add, That a Pound of Dantzick Vitriol, and a Pound of Sea-Salt, the one calcin'd lightly, and the other decrepitated, being distilled in a well coated Retort, by degrees of Fire, giving at the last a very strong one; when the Vessel was taken off, we found that the Heat had here and there melted it; and that the Fluxed Caput Mortuum had corroded the Glass, fetching off Films from it; and those Parts which did not appear to the Eye manifestly wasted; seemed by their brittleness to have been penetrated; fo that their Texture was spoiled by the Saline and Vitriolate Particles.

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PROP. II.

Common Glass is not ordinarily permeable by Chymical Liquors, the strong and subtle, nor by the directly visible or odorable expirations of Bodies; the absolutely speaking, it is permeable to some corporeal Substances.

And, First, It is manifest, not only that several Spirituous Liquors and Menstruums, may be kept in Glass Vessels without sweating through them, but even distilled in them; and I have found that neither Salt of Tartar would by being held in a Glass Bubble in the Water. nor would Sal-Armoniac penetrate it, fo as to make its way out. But it is to be considered, that some Circumstances may vary these Obfervations, as when the Texture of Glass is too lar and open; or when the Bodies are vehemently agitated with Heat, or are too subtile; and have a certain congruity with the Pores of the Glass. For I have seen a fort of Glass fo foft, that not only hot Liquors, but moderately Corrofives would work upon it; and I have heard, that some fort of Glass is apt to be prejudiced by corrolive Liquors. And I was told by one, That he feveral times observed Gold to penetrate the Pores of Glass; and I have observ'd Fumes to make their way through the Pores of ordinary Glass, upon difilling of Spirit of Harts-horn with a strong Fire.

And that the Pores of Glass are penetrated by some Substances, is evident, by the Effects

of Cold and Heat, on Bodies contained in fealed Giasses; and that so gross a Body as the Ef. fluviums of Earth will penetrate Glass, and work on Iron contained in it: And Light it felf appears evidently to be contained in close ly fealed Glasses; and by a cantinued Heat I have found the Parts of Fire to penetrate Glass, and add to the weight of Iron sealed up; and having tryed this Experiment with Filings of Copper, I found that their Colour was much altered, some of them being adorned with exceeding vivid Dyes; which they yet retain without being increased in weight. as if they were not able to flick themselves fall enough in the Pores of the Metal, to add to its Gravity. And I had a Liquor which would vary its Colour, as if something in the Air was fuccessively communicated to it, and receded again.

And to these, other Instances may be brought from what may be observed in painting Glass; for the Pigment being laid upon the Glass, and that placed upon a Bed of Lime, and then continued in a violent Heat, the Pores of the Class will be so opened, as either to imbibe the Parts of the Pigment, or to vitrifie and mix with it: And I have found, that by laying prepared Silver upon Glass, and placing that upon live Coals; when it was nealed a while, by giving it a sufficient degree of Heat, the Glass will acquire a Yellow, and almost a Golden Colour, which is not to be washed off; the way of preparing this Silver, is not always the fame, the Glass-painters usually adding to it Antimony, Yellow Okre, or the like.

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But lince the Colour proceeds from the penetration of the Silver into the Pores of the Glass: I aftally make use of the Powder of Silver akined, by burning Sulphur upon thin Plates; and I have often coloured Glass barely by the the of Leaves of Silver laid upon the furface of the Glass, and moistened with something to been it from flying away. And I have often observed that tho' the Glass betwixt and the Light appeared Yellow, yet being held from it it appeared Blue; which is a Confirmation of what we have inferred from the variation of Colours, in a Tincture of Lignum Nephriticum; Viz. That they may be folved by Mecharical Principles. And that the Colour of Glass tinged, proceeds from an Incorporation of the Parts of a Pigment with it, tho' they penetrate not the whole Substance, but tinge the superficies, (as I observed in Glass Plates, which were part of the Windows of Sr. Paul's Church before it was burnt) may be urged, fince the Parts of the Silver may be wrought on by the fix'd Salts in the Glass, and afford different Colours, according to the difference of the Bodies that work upon them, as Copper with Spint of Urine, give a deep Blue; with Spirit of Salt, a fair Green; and with Aqua Fortis, a Coloor partaking of both. And in making Glass of Lead, with Minium, and White Sand, or Crystal, the Glass will be of an Amethystine Colour, but if you add a due proportion of calcin'd Copper, the Metal will give it a good Green; so as to pass for no bad Emerauld; and I remember, that distilling some Gold in a Retort, amalgamed with fuch Mercury as would G g

grow Hot with it in the Cold; the Matter did, before it flew away, perfectly stain an Inch in the Diameter of the bottom of the Glass, with a Colour, which, held from the Light, appeared like that of the better fort of Turquoises; but when interposed between the Window and the Eye, appeared of a some what Golden Colour. And Gold incorporated with Mercury, and kept in digestion, when the Fire was once very vehement, it burst the Vessel and flew away, but tinged the lower part of the Glass quite through, with a glorious Red Colour, not inferior to that of Rubies.

CHAP. VIII.

Of the Porousuess of Animal Bodies.

Of the Po rosity of Animal Bodies THE First Argument I shall urge for the Porosity of Animal Bodies, is from their Structure; for since they are most of them compounded of dissimilar, or similar Parts, we cannot suppose those so exactly united as not to leave Pores and Intervals betwixt them, whose Number and Variety must be very great.

A Second Argument of their Porofity, may be deduced from the apposition and consumption of their Nutriment; and which may be illustrated by observing that those moist Particles with which the Earth is moistened, being agitated by the Heat of the Sun and Air, those that happen to be commensurate

to the Pores of the Root are impelled into it, and thence conveighed into the other Parts of the Tree, being conveighed in the form of sap, which passing through new strainers receives alterations requisite to turn it into Wood, Bark, Leaves, Fruit, &c. And in roung thriving Animals it cannot be imagined, how the nourishment should be conveighed to all the Parts, without supposing them furnished with Pores for its reception and passing the supposition of the passing them supposed to the parts, without supposing them supposed to the parts.

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Another Argument of the Porofity of Animal Bodies, may be brought from the plenty of Humours carried off by sweat, and insensible Transpiration. And by the help of good Microscopes we may discern Pores in the skins of Animals, and especially in the inward sides of Gloves which are nothing but skins dreffed; and they are further evident, fince Quick-filver readily passes through the Pores of Sheeps skins, and leaves the drofs behind in the Leather; and the like I have tryed with the skin of a Man's Arm tanned, which Bores according to Steno and Malpighius, are the Excretory Vessels of the Glandula Miliares contained in the skin. and that the skins and shells of Eggs are not roid of Pores, appears, fince the moisture contined is fo far diffipated through them as b diminish their weight. And Sanctorius in his Medicina Statica tells us, that if the Meat and Drink taken one day amounts to cit Pound, five Pound will be carried off minsensible Transpiration. And he elsewhere that in the space of twenty four hours a the Winter time a healthful Body may ex-

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Book V.

hale fifty ounces or more a great part of which is carried off through the Pores of the Membranes of the Aspera Arteria: And if ones finger in hot Weather be held to the Surface of any cold Body, it will presently be fullyed over with the steams that issue out of the Pores of the skin. And their Porofity is further confirmed by observing, how foon those black and blue fpots in the skin occasioned by bruises are removed: for which use Helmont employs white Bryony root, and I have feen a Poultefs of chopped Hyslop and fresh Butter remove the Pain, and black colour of a contusion in a little time.

And not only the Skins but the Membranes of Bodies are stocked with Pores, since the Bladder of a dead Animal appears to be full of them; for if Salt of Tartar be put into a Bladden and it bethen immersed in Water enough of it will penetrate the Bladder to dissolve the Salt and render it Liquid; and the like succeeded, but much more flowly when the Experiment was tryed with Sugar; and fome fay, that Syrups made this way, instead of using ordinary Water, are much more preferable. And as a further instance of the Porosity of the shells of Eggs, I shall add, that one having been immersed in very sharp Vinegar, tho' the fhell was part of it confumed, yet being taken out and wiped, it was confiderably fwelled and heavier than before, the Menstruum being imbibed and infinuated into the Pores of it. And I am not only told, that the Chineses had a way of falting Eggs, but I found by coating one over with Clay, after it had lain fome time in Brine,

Brine, the fubstance contained tasted evidently Salt. And I know a Physician who was affeded with a giddiness upon the use of Clusters of Sack, and another told me, that having applved Tobacco to the fore Leg of one of his Patients, it caused her Stomach to turn, or actual Vomiting; and another told me, that he wed to Vomit himself, by applying Decoctions of Tobacco to his wrifts or other extream Parts. and it is a common custom to Purge Children by the Application of external things; and ithath been observed, that Bathing the fore Head's of Children, with a Decoction of Tobacco hath caused a giddiness. And a Virtuoso told me, that having taken another by the Hand, which was gently befmeared with Oyl, it gave him three or four stools presently.

And to what hath been delivered of the Porofity of Membranes, I shall add the aptness of Lute-strings, to imbibe into their Pores moist Particles; and also the Metastasis or Translations of Morbifick matter in diseased Bodies; as the matter which causes a Feaver, being discharged upon the Brain causes a Delirium; and other Distempers as it is discharged upon the Pleura, the Membranes of the Chest, the Throat

or Guts.

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Another Argument of the Porousness of Animal Bodies, may be drawn from their aptness to imbibe Effluvia from without, as when Cantharides externally applyed affect the Bladden; to which inflance may be added the effects of Plasters, and Oyntments, and Pericarpia; for 1 bave often cured Agues with a Mixture of Curtans, Hops, and Bay-Salt; and it is volgarly

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known, that Mercury externally used in Oyntments will salivate. To which may be added the effects of Periapta and Appensa; of Bloodstones in stopping of Hemorragies, and of another kind of Stone made use of by the Indians in Obstructione Menstruum. And I have found my self that the Moss of a dead Man's skull would stop an Hemorrhage, as soon as warmed by the contiguous skin. And Zwelfer tells us of one who preserved several from the Plague, by using Helmonts Troches of Toads in Amulets; and several of these Troches being put upon the Plague sores of the insected, they were afterwards cured by the use of vulgar Remedies.

And to these I shall add, that having drawn a Spirit from a Mixture of flowers of Brimstone, powdered Sal-Armoniack, and good Quick-lime in equal quantities, by degrees of fire in a Retort till the fand be red hot, if a piece ofCopper be foulded up in Sheeps Leather, and held over the Vial it is contained in, the Metal will be tinged with the rifing fumes, without discolouring the Leather; the same will succeed, only more slowly, through a double fold of Leather: And all the alteration the Leather received from these pervading fumes was, that they gave it a fulphureous fmell. And this Experiment may favour the accounts we have of the Effects of Lightning, which hath been observed to discolour the money in Men's Pockets, without burning them; and the same effect hath been taken notice of by some, who have ascended a burning Mountain in America. And it is observed, that Lambs

lambs Leather hung up in the Air, acquires a wiffere, which adds confiderably to its weight. And to these instances may be added, the effects of Contbarides upon some that only carried den in their Pockets, the Effluviums of them having caused them to pis Bloody Urine. And sa further Confirmation of the Porougness of Bodies I shall subjoyn, that the Permeating Limor above mentioned had the like effect upon Copper, through the tough skin of an Egg. and likewife through a wet Sheeps Bladder; and to confirm what I have faid, of the Porounes of Animal Bodies I shall add, that Gentleman who had a long time a Perforation in his Thorax, and was wont to inject medicated Liquor often to cherish the Parts, and likewise to wear a filken Bagg stuffed with Aromaticks upon the Orifice, he not only had the Tafte of the Liquors in his Mouth, but the Aromatick Bag, when fresh, would perfume his Breath in Respiration. And Galen tells us, that Honey and Water having been injected into the Thorax, have been discharged through the Aspera Arteria by coughing. Min who was troubled with a dry short Cough, we found some white curdled Matter betwixt the Pleura and the intercostal Muscles, which feemed to occasion the Cough by some noxious Effevia transmitted to his Lungs.

And to these Instances I shall add, that it seems probable that these Humours collected in the Abdomen of an Hydropical Person, can be carried off no other way but through the Pores of Membranes, upon the use of Diuretick and Purging Medicines. And an Instance not much

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inferior, is the Translation of the Matter of an Empyreuma, fo as to be voided by stool or Urine; and I have observed my felf, that when I have been present at the Dissection of a Dog. whose Blood smelled very rank, the Excrements evacuated by siege, some time after, would retain that Odour. And a famous Surgeon and Anatomist relates, That one who was ill of a Dropfey, judged to arise from a Schirrus of the Spleen; by applying a large Spunge dipped in Quick-lime-water, to the Region of the Spleen, the Schirrus was dissolved, and the Hydropical Humor evacuated, And Galen tells us, that part of the Humors collected, upon the breaking of a Bone, is discharged through the Skin, whilst the Callus is a forming.

And not to repeat what Arguments have been already made use of, to prove the Porosity of Animal Substances in general; that the Nails of Animals are porous, may be argued from their aptness to be tinged with a Solution of Silver in Aqua Fortis, or of Gold in Aqua Regis; the former giving them a dark and black Colour; and the latter, tinging them with Purple Spots; which would continue, 'till by the growth of the Nail, they were forced to be pared off. And one thing in these Tinctures worthy our Notice is, that tho' the Mensiruums are Acid, and Corrosive, yet the Tinctures are not, the Taste of the Tincture of Silver being bitter, and the other styptick.

And the same method may be taken to prove the porosity of Ivory; since a Tincture of Silver in Aqua Fortis will tinge it with a dark and blackishColour, which is not to be washed off.

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And I have long fince tryed, that a Solution of Gold will give it a fine purple Colour; and that too when both the Ivory and the Liquor were cold. Copper diffolv'd in Aqua Fortis, hains Ivory with a bluish Colour. And even is the Cold without the Use of Corrosives, I have stained Ivory with a permanent Blue, like a Turquois, by suffering a Solution of Copper

in Sal-Armoniac to dry upon it.

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But to return to the Porofity of Bones; it may be argued from the Marrow found in the Civities of them; fince nourishment must needs be conveyed to it, and it is not improbable that Blood Vessels penetrate at the least some depth into the substance of Bones, tho' the Juice received from them, may afterwards be conveyd through the more internal Parts of them; for we fee that the Lower Jaw is perforated by a Nerve, and also a Vein and an Artery to carry and return Blood for the Nourishment of the Teeth; and I have been told that Blood-vessels have been observed by good Anatomists, to enter into the fubstances of larger Bones; and Blood hath not only been observed in the cavities of the Bones of younger Animals, but in the fpungy Substance of feveral larger Bones. To which may be added in favour of their Porofity; the blackness which they acquire when put into a competent heat, and the fatness which they afford; as also their specifick Lightness, and their aptness to be corroded with sharp Menfruims. And Bones are observed in moist Weather, not only to grow heavier, but they imbibe the moisture of the Air so much, as evidently to fwell. And to these Instances I shall fubjoin

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Subjoin what Observations I have made on large Nov. 15. we weighed two (entire or unbroken) Marrow-bones, and found the one to weigh twenty nine Ounces half a Dram, and the other twenty four Ounces four Drams and thirty Grains. November 24. The former weighed twenty nine Ounces fix Drams, and the latter twenty five Ounces, one Dram, and thirty Grains. December 28. The former weighed twenty nine Ounces, three Drams, and fifty five Grains; and the latter twenty four Ources, feven Drams, and thirty nine Grains. June 7th, The next Year the former weighed twenty nine Ounces, two Drams; and the latter twenty four Ounces, seven Drams; from whence it appears, that Bones are Porons, fince they imbibe and lose moist Effluvia again. And that there may be Vessels fine enough in the substance of Bones, to convey Nourishment, may be rendred probable, by what the Learned Sennertus hath observed, viz. That Hairs being cut in the Plica Polonica, they have been observed to bleed, so that they seem to be made up of a Bundle of cylindrical Pipes. And as a further Instance of the Porosity of Bones, I shall add, that Mercury hath been found lodged in the Bones of those that have been salivated in the Pox. And the same is attested by Euft chius Rudius (apud Sennet.) Lib. 5. de Morbis Acutis, Cap. 15. And what hath been faid may ferve to favour the Use of Amulets and Periapta; or at least discountenance their being too suddenly rejected.

CHAP.

CHAP. IX.

Of the Natural History of Human Blood.

PART. I.

Containing a List of Titles for the History of Human Blood.

Defore I proceed to enumerate the Titles of the Nalaid down for a Natural History of Human tural Histo-Blod, it may be requisite to advertise, that the man Blood. first Set which I call primary, and to which those in the Appendix are secondary ones, confift of fuch as offer themselves to the View at the First fight, which need not be either nicely Methodical, or accommodated to any Hypothefir. The second Class consists of such as are to be ranged into a better order, being of a greater extent and more comprehensive, so that one Topick may be branched into several subordinate ones, or secondary Titles. And from the Materials drawn together under this Head, may be deduced a Set of Titles, reduced into an inchoate Natural History of the Subject they have Relation to.

And fince the Subject to be treated of is very difficult or comprehensive, as the Generation of Living Creatures, Magnetism, Fermentation, Gravity, &c. it may be useful, if not necessary, to interpose betwixt the Titles of the last, and those of the first Order, a Set of Titles that may be called of the middle Or-

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der or Classis; in which the Nature of the Subject is more narrowly look'd into.

Titles of the first Order for the Natural Historys

Titles for the Natural History of Blood. 1. Of the Colours of Human Blood, Artenal and Venal.

II. Of the Taste of Human Blood.

III. Of the Odours of Human Blood.

IV. Of the Heat of freshly emitted Human Blood; which is observed to be much violenter after it hath run a while, than when it first began The Blood that came out of the Veins of a young Gentlewoman, falling upon the Ball of a Thermoscope, caused the Liquor to ascend above an Inch nearer the smaller and upper Ball of the Glass And in another Tryal it was raised almost a high as to the Ball of an ordinary Thermoscope; but being held in the Blood of a healthful and lusty Man, the Heat raised the tinged Liquora good way into the upper Ball; which was higher than the Heat of the Air in the Dog-days vfually does, and the Blood of a healthful Man continued its Heat fo lo long, that it raised the tinged Liquor three or four Fingers breadth when it was coagulated.

V. Of the inflamability, and some other Qualities of Human Blood. A piece of Human Blood being dryed 'till it was fit to be powdered, and then held in the flame of a Candle, it took Fire, and afforded a flame not much unlike that which caused it, burning with a Crackling noise, and here and there melting; and if it was laid upon live Coals, and now and then blown, it

would

rould yield a very yellow Flame, and during its Deflagration, would feem to fry upon the Coals, and in a great measure to melt into a Black Substance almost like Pitch. And some of the Powder of Blood being cast into the same of a Candle, they took Fire in their passage, and flashed not without some noise, as if they had been Rosin.

VI. Of the Aerial Parts naturally mixed with Human Blood; and also found in its di-

find Parts.

VII. Of the Specifick Gravity of Human Blood entire. It may be different in feveral Persons, according to their Sex, Age, Constitotion, &c. as also in the same Person, according to the time of the Year, the Day, or, as it is taken out at a less or greater distance from a Meal. But to make an Estimate of its Specifick Gravity, we took the Blood of a found Min, and put it into an oblong Glass; and when it wassetled, we marked with a Diamond, that part of the Glass to which the Liquor wrought; and then weighing the Glass, and the Blood contained in a very Tender Ballance; we poured out the Blood, and having washed the Vellel, we filled it up to the fame Mark, and then weighed it in the fame Ballance; and then weighing the Glass, and deducting that from the weight of the Glafs, and the two Liquors, the Water weighed nine Ounces, fix Drams, and fifty Grains. And the Blood equal to it in Bulk, weighed ten Ounces two Drams, and four Grains, fo that the Blood being three Drams and fourteen Grains heavier, it was about part heavier than Water.

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VIII. Of the Specifick Gravity of the Fibron and Red part; and of the serous part of the Blood.

IX. Of the Confiftence of entire Human

Blood.

X. Of the Disposition of Human Blood to Concretion; and the time wherein it was performed.

XI. Of the Liquors and Salts that coagulate Human Blood. Clotted Blood being kept some Hours in Spirit of Wine, which is a Mon-firmum fit to dissolve some Bodies, it was take out as hard as if it had been dryed by the Fire.

XII. Of the Liquors and Salts that obstract

or dissolve its Coagulation.

XIII. Of the Liquors, &c. that preserve He-

XIV. Of the Mixture that Human Blood may

receive from Aliments.

XV. Of the spontaneous or Natural Analysis of Human Blood into a serous and a sibrous Part.

XVI. Of the respective Quantities of the serous and fibrous part of Human Blood.

XVII. Of the differences betwixt the ferons,

and the Red part of Human Blood.

SVIII. Of the Artificial or Chymical Analyfis of Human Blood; and first of its Spirit.

XIX. Of the Volatil Salt of Human Blood, and of its Figures. This Salt is so sufficient, that one part of it may be brought to boil, whilf the other slies way; and this Observation will hold in most Volatil Salts. And tho' this Salt, when sublimed, looks white and Clean, and a very homogeneous substance, yet I am apt to think,

that it is made up of Parts of Matter of fres and shapes different enough, for having reighed some Grains of re-sublimed Salt of Hu-Blood, that feemed pure, its fmell was ray ftrong and diffusive, so that one would bre expected it to fly away in a little time, but me observed that it was very little diminished in feven or eight days time; yet what remaind had loft its Odour, but retained a faline Tafe; and being put upon a Solution of Sublimate in common Water, turned it White, fo hat its diffusive and penetrant Humour seemd to depend on some more volatil Parts of the Mood. But it may be a Question to be solv'd by further Experience, whether the fixedness of this Salt may not proceed from the Coalition of an Acid Salt in the Air.

A Dram of Volatile Salt of Human Blood fiblimed in a Lamp-furnace, was put into common Water, and when a Thermoscope was brought to its right temper, being immersed in this mixture, the tinged Spirit of Wine manitelly subsided about , parts of an Inch; tho' a considerable part of the Salt lay undissolved in the bottom of the Water. And when the Liquor would descend no further, we added to the Solution strong Spirit of Nitre, 'till it would to longer make a manifest Conflict with the salt; and then we observed, that whilst the Conflict lasted, the Spirit of Wine rose above three Inches and a half higher than the station t frood at before. The figure of this Salt may be either confidered in reference to fingle Grains, or an Aggregate of them, when they are raised and sublimed to the top of the Glass;

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the latter of which may be best observed. when they fasten themselves to the inside of the Glass that is fet to receive them; for in the begining of the Operation, one may obferve the little faline Concretions to lye in rows. fometimes straight enough, and sometimes more or less crooked, with different Coherings and Interferings, fo that they fometimes represent either Trees, or their Branches or Harts-horn, or. which are casual figurations depending on several accidental causes and circumstances, as the degree of fire made use of to sublime the Salt, the quantity of the ascending matter in reference to the Capacity of the Vessel that receives it. And the like diversity of Configurations I have observed amongst the Salts of other Volatile Salts, as well as those of Human Blood. And as for the fingle grains of the Salt of Human Blood, I discovered a good many of them to be finely shaped; but whether they were accidental or not, experience must determine. But these figures were only observed in the sublimate of the first Distillation, for those obtained by rectifying the Salt and distilling it again, were of a considerable bigness and solidity tho' differently shaped, some of them being Cubes, others Parallelopipeds, others Octoedrons, being almost like grains of Allom; but most of them prettily shaped; being comprehended by Planes, smooth, finely figured, and aptly terminating in folid Angles, as if the concretions had been cut and polished.

Another way I took to discover the figures of the Salts of the Blood, was to rectifie the Spirit

Spirit, fo that it may be fully fatiated with the Salt, whilst the Liquor continues warm; for when it is refrigerated, a number of faline Concretions of different fizes, several of which hoot into very smooth Crystalline Plates pretfigured, having their broad and parallel Surfaces of an Hexagonal or an Octogonal

figure, regular enough.

A drachm of dry Volatile Salt of Blood, being disfolved in some distilled Water, we dropped into it good Spirit of Nitre, till the two Liquors would no longer manifestly act one upon another, and when the conflict ceafed, we flowly evaporated the fuperfluous moisture, which steamed almost all away before the faline part would coagulate. At length it became dry, and the middlemost part appeared in the form of thin Crystals, not unlike those of Salt Petre; but the rest which was by much the greatest part of the Concretion, feemed to be a confused mass without any difind figure; and this mass weighed but twelve grains above a drachm; fo that Volatile Salt of Blood may be satiated with a fifth part of its weight of the faline Parts of Spirit of Nitre. This Salt exposed to the open Air in a window was very apt to run per Deliquium, and a little of it being put upon a live Coal, it melted and seemed to boil; and towards the end made a noise, and afforded a flame yellower than that of common Nitre.

XX. Of the Phlegm of distilled Human

Blood.

XXI. Of the two Oyls of Human Blood. By distillation in a Retort, it affords an Empyreumatical H h *

reumatical and a very fetid Oyl, whose color is almost black; which feems to be occasioned by the increase and opacous redness of the Lignor. fince some of it being spread thin upon Glass. and held against the light, appeared yellow, or of a reddish colour, as they lay thicker or thiner upon it, but when it was well dryed before committed to Distillation, it yielded a greater quantity of Oyl, fo that once out of a Pound of not over-dryed Blood, we obtained an ounce and a half of Oyl, and from another we had a much greater quantity of Oyl. And having once prepared Blood by a convenient Digestion, and rectified very carefully the distilled Liquor that came over with the flame of a Lamp, I obtained amongst other things two · Oyls of very different colours; the one being of a pale Amber or yellow colour, and the other of a deep red; and tho' these Oyls were both of them afforded by the same Blood, and were clear and pure enough; yet they would fwim in distinct Masses one over another, and if mixed by shaking would again separate like Oyl and Water. Whether the difference in specifick Gravity betwixt these two Oyl, kept them from mixing permanently, as well as it kept them distinct before they were mired; or whether the seeming incongruity proceeded from the Texture of these Liquors! shall not now stay to dispute.

To shew that the Oyl of Human Blood contains several saline Particles, capable of being separated from it, we put a parcel of unredified Oyl, to a convenient quantity of distilled Water, and having mixed them sufficiently by

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ration, fo that the Water might rob the Oyl of its separate saline Particles, the event was that after the Liquors were well fetled. the Water was found to be impregnated with filine Particles, that it obtained by diffilution from the Oyl; so that it acquired a moderatly brisk tafte, and would readily turn Syrup of Violets green; and precipitate a white Powder out of a folution of Sublimate; but whether the like will succeed with other Empyreumatical Oyls or not, drawn from Bodies belonging to the Animal Kingdom, I shall leave others to determine.

Having put some unrectified Oyl of Human Blood into a concave piece of Glass, and then dropped as much Oyl of Vitriol into it, as might amount to a third or fourth part of the fetid Oyl, we stirred them together with a lender piece of folid Glass, upon which the Mixture emitted store of whitish fumes or Smoak; and acquired a confiderable degree of Heat, so that tho' it amounted to not much more than a spoonful, yet I was not able to hold my finger under that Part of the Glass, that contained the Liquor.

Having taken some Empyreumatical Oyl of Human Blood unrectified, tho' it was dark, and groß, and muddy, yet it would eafily in the cold dissolve in rectified Urinous Spirits. to which it gave a reddish colour deep e-

nough.

XXII. Of the fixed Salt of Human Blood. To obtain but one ounce of it, there is requisite to employ a confiderable quantity of Blood; and duly prepared by a very obstinate fire; for the

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Caput Mortuum being kept three or four hours in the fire, it will yield no fixed Salt at all: But having by an obstinate Calcination obtained three or four drachms of this Salt, I found that it was of the Nature of common or Sea-falt. tho' a little different; for it tafted like it, and a strong folution did not readily turn Syrup of Violets green, nor precipitate a Brick colour. or brownish yellow, no more than a white Powder, out of a folution of Sublimate; nor did the Spirit of Salt dissolve it as an Alkaly. And having put a little Oyl of Vitriol upon our dryed Salt, it immediatly, as it feveral times did upon common Salt, corroded it with great violence, and with much foam and Smoak We also dropped a little of it dislolved in Water, upon a folution of Silver made in Aqua Fortis, upon which a white Powder was immediatly precipitated: And having put fome Leaf-Gold upon Aqua Fortis, which would not work upon it, whilst it was swimming there without being so much as discoloured, I put a little of our powdered Salt into it, which being thereby turned into a kind of Liquor, did without the affiftance of Heat, prefently dissolve it.

XXIII. Of the Terra Damnata of Human Blood. From twenty four ounces of dryed Blood, we got after two days Calcination, but two drachms and nine grains of Earth; which probably was not pure Earth, fince it had a red colour like that of Colchetar of Vi-

triol.

XXIV. Of the Proportion of the differing Subfrances Chymically obtain'd from Human Blood. They n- nd it, nd of

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they are scarce to be determin'd, not only becase of the sometimes great disparity, as to proportion, that may be met with of the brous part to the Serum, in the Blood of fereral Persons; but of the same, according to different Circumstances, and also, because it is and to distil the pulverised part of the Blood; face no one hath so much as taken notice of the Necessity of shifting the Retort, to gain as much Volatile Substance as may be obtained; and leave as little as may be in the Capit Mortuum. For having distilled a quanmy of dryed Blood, the same Heat which made be lower part pass in the form of Exhalations to the Receiver, made the matter to swell, fo that it lifted up a confiderable quantity of Black Matter to the upper part of the Veslel, which common Distiller would have called a Caput Mortuum, tho' to a difcerning Eye, it appeard to be of the same Nature with the Matter first put in, tho' blackened by the ascending fomes, therefore taking it out, and mixing It with the remaining Substance, that was more of the Nature of Caput Mortuum; it was committed again to Distillation in another Retort, whereby we obtained more Oyl, &c. perceiving that even this Caput Mortuum had upon the top of it, a pretty deal of Matter, which was not sufficiently despirited, I caused to be distilled again in a fresh Retort, in which it afforded a not contemptible quantity of Volatile Matter. And having thus in three Retorts distilled twenty four Ounces of dryed Homan Blood, we obtained of Volatile Sub-Stances, Hh 3

stances, viz. Spirit, together with a little Phlegm, White Salt, and very high colour'd Oyl thirteen Ounces and one Dram, besides feveral parcels of thick Oyl that fluck to the Retorts and the Receiver, which we judged to be feven Drams more; fo that the whole Quantity of the Volatile Part amounted to fourteen Ounces, of which the Oyl was fix Ounces fix Drams, and the clear Liquor fix Ounces, three Drams and a half, besides the Volatile Salt, which, when the Spirit was drained from it, appeared white but wet; fo that it was not possible to determine exactly, neither how much Liquor it yet retained, nor how much it felf weighed; but it will be no hard matter to guess near the Truth to any Man that knows, that having carefully sublimed the Salt, there remained in the Glass two Drams and five Grains of Phlegmatick Liquor; which was not wholly void of Salt; and of Volatil Salt in a dry form, we obtained one Ounce and two Drams and a half; the Caput Mortuum amounting to eight Ounces and a half, and fomewhat more, which being calcined for two or three Days together, afforded not White, but brounish-red Ashes, whence we obtained feven Drams ; of White and fixed, but not a truly lixiviateSalt; and two Drams and nine Grains of Earth. But indeed confidering the great proportion of each of these Substances loft in distillations, it will, upon that account, be a hard matter to determine the true proportion of the Principles of Human Blood.

XXV. Of

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XXV. Of the Fermentation or Putrefaction of Human Blood and its Phænomena.

XXVI. Of the Mechanical Uses of Human

Blood, as in Husbandry, &c.

KXVII. Of the Chymical Ilses of Human Blood.

XXVIII. Of the Medicinal Uses of Human

XXIX. Of the difference betwixt Human Blood, as its found in found Persons, differently constituted, and circumstantiated, as Men, Women (when Monstrous and when not) Children, Moors, Negroes, &c.

XXX. Of the affinity and difference betwixt the Blood of Men, and that of several other Animals, as Quadrupeds, Birds, Fishes, and

Sanguineous Infects.

XXXI. Paralipomena relating to the History

of Human Blood.

XXXII. Micellaneous Observations, periments and Enquiries about Human Blood.

Were this Treatife applyed to any other than extravasated Blood, to these we

might add the following Titles.

I. Of the process of Sanguification, or the feries of changes that the Aliment succesfrely undergoes, from its first being taken in at the mouth, till it be turned into Blood.

II. Of the motions of the mass of Blood,

and particularly its Circulation.

III. Of the Chyle, Lympha, and other Liquors, that are supposed to enter and mingle with the Blood.

IV. Whether Hh4

IV. Whether Phlegm, Gall and Melancholly, be constituent Parts of the Blood.

V. Whether fome other Substances may not, with as much reason be admitted into the composition of the Blood.

Titles of the first Classis, for the natural History of Human Urine.

Titles for the Natural History of Human Urine. I. Of the colours of Human Urine.
II. Of the tafte of Human Urine.

III. Of the Odours of Human Urine fresh and putrified.

IV. Of the Heat and Cold of Human

Urine.

V. Of the specifick Gravity of Human Urine.

VI. Of the Confiftence of Human Urine, as to Density, Viscosity, &c.

VII. Of the Aerial Parts contained in Hu-

man Urine.

VIII. Whether Human Urine is a fit Liquor for Fermentation properly so called.

IX. Of the differences betwixt fresh and

stale Human Urine.

X. Of the Fermentation or Putrefaction of it, and the time it requires.

XI. Of its Spontaneous feparation of

Parts.

XII. Of its Vulgar Analysis by Distilla-

XIII. Of some other ways of distilling Human Urine.

XIV. Of the proportion of the Principles, or Ingredients of Human Blood.

XV. Of

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IV. Of the Spirits of Human Urine.

IVI. Of the Phlegm of Human Urine.

XVII. Of the Volatile Salt of Human Urine.

XVIII. Of the fixt Salt of Human Urine.

XIX. Of the compounded Salts of Hurnan Urine.

XX. Of the shining Substance obtainable from Human Urine.

XXI. Of the Salt that is Predominant.

XXII. Of the Empyreumatical Oyls of Human Urine.

XXIII. Of the Mellago, or Rob of 'Human Urine, and its uses.

XXIV. Of the Terra Damnata.

XXX. Of fome accidental differences of Human Urine, as it's emitted in the Morning. or at certain distances from Meat, or after the of certain Aliments, or Medicaments, as Afparagus, Turpentine, &c. Or at different seasons of the year, as Winter, Summer, &c.

XXVI. Of the affinity of Human Urine with divers other Bodies, especially Veggetables and

Minerals.

XXVII. Of the Hostility of Human Urine

with Acids, &c.

XXVIII. Of the affinity and difference betwixt Human Blood, Urine, Gall, Milk, &c. and divers Liquors, or Juices belonging to the Animal Kingdom; particularly of the comparison betwixt Human Ulrine and that of Beafts.

XXIX: Of the Mechanical uses of Human Urine.

XXX. Of

XXX. Of the Chymical uses of Human Urine, and its Parts, especially as a Menstru-14771.

XXXI. Of the Medicinal uses of Human

Urine External and Internal.

XXXII. Paralipomena relating to the Histo-

ry of Human Urine.

XXXIII. Promiscuous Observations, Experiments and Enquiries about Human Urine.

The second Part of the Natural History of Human Blood, containing Miscellaneous Experiments and Observations about Human Urine.

The third Part containing Promiscuous Experiments and Observations, about the Serum of Human Blood.

Aving separately weighed the Serum, and I the confistent part of the Blood, the latter weighed four ounces, fix drachms and a half, and the former three ounces, fix drachms. And having taken the same measures with the Blood drawn from another Person, the fibrous part weighed four ounces, five drachms, and the Serum four ounces. But from these Experiments it does not follow, that the fibrous part is alone heavier than the Serum; fince a great deal of the latter is dispersed through the Pores of the former, which

which appears, fince four ounces, five drachms, at thirty four grains of the fibrous part of Blood being distilled in a digestive Furnace, the dryed Blood remaining weighed but one omce, three drachms, and thirty four grains; whereas the ferous Liquor distilled from it amounted to three ounces, fifty three grains; and the like tryal being again repeated with mother parcel of Blood, the dryed mass amounted to one ounce, fix drachms, and fifty grains; and the Phlegmatick Liquor distilled from it, to feven ounces.

Red Sealing-Wax suspended at a Hair, weighed in the Air one drachm, fifty fix grains; in Water thirty five; in Serum thirty three. And having made use of an Instrument purposely made, when common Water weighed 253 grains, an equal bulk of Serum weighed 302; and the Serum of the Blood of another . Person being weighed, it wanted but two

grains of the weight of the former.

Serum which was tinged with Blood being frained through Cap-Paper, the Liquor which passed through it was of a yellow colour.

Spirit of Salt being dropped into Serum, coagulated some Parts, which subsided in the form of Cheefe-Curd; and Oyl of Vitriol had the same effect, but more powerfully : But Spirit of Sal-Armoniack rather made it fluid. Oyl of Tartar per Deliquium produced a white Card, by uniting with fome Parts of the Serum, but not so powerfully as the other had done. Spirit of Wine rectified produced a copious white Curd, but fo foft that it swam upon the top of the Liquor.

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Upon an infusion of a solution of Sublimate, it yielded a white Curd; but some of the Serum of Human Blood being poured upon filings of Iron, the Liquor dissolved some of the Steel; which appeared, since upon an addition of some of an infusion of Galls, the Liquor which before was muddy and thick, laid down a whitish Sediment; and a convenient quantity of the infusion being added, the two Liquors united into a consistent Body, wherein the Eye discovered no distinct Liquor at all.

But having put some of our Liquor upon filings of Copper, which, when wrought upon by Bodies that have in them any thing of Urinous Salt, usually give a conspicuous Tincture, we accordingly found, that the Metal was in a few hours discoloured by the Menstruum; and afterwards it began gradually to grow more blue, and in a day was of a deep Ceruleous colour: And to shew that this colour proceeded from some Volatile Salt latent in the Serum, we mixed some of it with Syrup of Violets, and found that it appeared of a fine green. And one thing observable in the Serum impregnated with Copper was, that I kept it several weeks in my Window without perceiving that it in the least funk.

About two ounces of Serum was left in a South Window three weeks in the Month of July; but did not appear in the least putrified; but had let down a considerable Sediment, and in three or four days after it stunk offensively; and that at the same time it was void of Acidity appeared, since it would not take

off the blue colour of a Tincture of Lignum Nephriticum. This fetid Serum being distilled in a low Cucurbite, the Liquor that first came over was so little Spirituous or Saline, that it would not in an hours time turn Syrup of Violets green; yet that it was not without a Volatile Alkaly appeared, since being dropped into a good solution of Sublimate, it caused it

to lay down a white precipitate.

Serum of Human Blood filtred through Cap-Paper, being distilled in a small Retort placed in a Sand Furnace; we obtained only a few drops of a darkish red Oyl, some of which fiblided to the bottom of the other Liquor, but the greater part fwam upon it; and after a good deal of infipid Phlegm had been drawn off, there came over a good proportion of Spirituous Liquor, which smelled almost like the Spirit of Blood, and contained a pretty deal of Volatile Alkaly; fo that it would readily turn Syrup of Violets green, and cause a white precipitate, and ferment with Spirit of Salt. And this Spirit being rectified in a small Head and Body, a good quantity of a thick Substance like Honey was left in the bottom of the Glass, which was for the most part of a dark red, and feemed to contain more Oyl than appeared upon the first Distillation. The Liquor that came over the Helm was purer, but not stronger than the first; but having put it into a Glass-Egg with a slender Neck, and given the Veffel a convenient Scituation in hot Sand, we obtained a Volatile Alkaly, that sublimed into the Neck in the form of a white Sait; from whence it scems to follow, that the serous part of the Blood affords the same Elementary Principles or Similar Substances, both as to number and kind. as the fibrous and confiftent part, tho' not as to quantity; that of the Oyl and dry Salt being less in a determinate proportion of Serum. than of Blood.

Tho' it be necessary, to loofen the Spirit of Urine from the more droffy Parts of it, that before Distillation it should putrefie for about fix weeks, yet if fresh Urine be poured upon Quick-Lime a great part of the Spirit will prefently be united, and ascend in Distillation: Encouraged by which Observation, I mixed Serum with Quick-Lime, upon which there enfued a transient Heat; and this mixed Body being committed to Distillation, first it afforded a Phlegm in a gentle fire; and then in a stronger. a moderate quantity of Liquor, that was thought to fmell manifestly of the Lime, but had not a brisk tafte; and this was accompanyed with a greater quantity of fetid Oyl than was expected. The other Liquor being flowly rectified, the Spirit which first came over had a strong and piercing smell, but less rank than common Spirit of Human Blood: Its tafte was somewhat fiery, and being dropped upon Spirit of Violets it presently turned it green; in a folution of sublimate with Water, and another of Quick-filver in Aqua Fortis, it presently made two white precipitates. And being mingled with some good Spirit of Sea-Salt, there appeared a thick and whitish Smoak, but neither any visible conflict nor bubbles; yet the colour of the Spirit of Salt feemed

feemed much heightned by this operation. And here I shall observe, that having set the lately mentioned Mixture of the Spirit of Senom and of Salt to evaporate, the Salt afforded by it was not like that of Sal-Armoniack, but the colour produced in the Mixture whilst shid, was so heightned in the Concrete, that it appeared of a Blood-red colour; but of such a confused shape, that it could not be reduced to any kind of Salt; by all which Phænomena this Spirit of the serous part of the Blood, seems to be very near of kin to that of the concreted mass.

To try whether the fixed Salt of Pot-ashes would have the same effect on Serum of Human Blood, to four Parts of Liquor we put one of Salt, and having distilled them slowly in a Glass-Head and Body, we obtained a good store of a Liquor, but not near so strong as that drawn off from Quick-Lime; and having rectified this Spirit by a gentle Heat, the two sirst spoonfuls which rose were not Spirituous but Phlegmatick; nor would it turn Syrup of Violets green, tho it afforded a light Sublimate when put upon a solution of Sublimate.

Having put one part of Salt of Pot-ashes into three of Human Urine, and slowly distilled them in a Head and Body; first a Spirituous Liquor ascended; which being set aside, we continued the Distillation till the remains appeared dry: In which operation we obtained not one drop of oyl; besides which it was observable that this Spirit of Urine was not near so settle, as that made

the common way; and that that Liquor which came over at the latter end of the Distillation. was fo unlike that which the Serum of the Blood affords us, that it was not only confiderably strong, and manifestly stronger than that which first ascended, but had a penetrateing and fiery tafte which left a lafting impreffion upon the Tongue, and made a notable Ebullition with Spirit of Salt, which the Spirit of Urine drawn from Quick-Lime did not; and whereas in the last Liquor I never observed any Volatile Salt to ascend in a dry form, in the operation made by the help of Salt of Pot-ashes, there ascended without Rechfication, feveral grains of Volatile Salt, one of which was Crystalline and very large, fo that it appeared to be like a Plate curiously figured; but some lesser corns of Salt hiding one part of it, I could not clearly difcern whether it were Hexagonal or Octagonal. And this Experiment being repeated a fecond time, the Liquor ascending was more Phlegmatick, tho' we both times applyed Salt of Pot-ashes taken out of the same Vessel, and the Urine of the same Person; but this Liquor being rectified per se, afforded more of a brisk faline Spirit, from which we obtained a pretty quantity of Volatile Salt in a dry form, and of a very white colour.

Having put betwixt two and three ounces of Serum of Human Blood into a Bolt-head, capable of holding four times as much, and having fealed the Glass Hermetically, and fet it aside, we observed the following Par-

ticulars.

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first, No alteration appeared in the Liquor in twelve Months, nor were any Worms or ligots bred in it; and tho' it be generally eleved, that Infects naturally breed in the lad Parts of Human Bodies, yet I have observed, that if Blood be so exactly closed up, that flies cannot blow upon it, and that too later it is patrissed, or blowed upon, it will ut breed them.

But, Secondly, In this Liquor there appearnot the least Mother which usually accommies Putrefaction; but the tip of the fealed is being broken off, a pretty deal of Air and out with a confiderable noise; and that Air had been confiderably compressed, siff it was penned up appeared, fince upon s emption a multitude of bubbles remained the Surface of the Liquor, as upon the opening of Botled Drink, or other Liquors, when the Vessels they are contained in come be unstopped. And to these Observations, hall add, that fome Sheeps Blood being shut p in Vacuo, upon a gentle Putrefaction, the Salick and Aerial Particles that were produed blew it up, with a forprizing noise. But, Thirdly.

The smell of our Serum was strong but not Gadavarous; rather resembling that of the Tindure of Sulphur made with Salt of Tartar and Spirit of Wine, or some such Sulphureous

reparation.

Fourthly, This Serum being committed to Diffillation in a small Glass Head and Body in a digestive Furnace, the Liquor which first came over, first smelled strong enough, yet

tasted not at all brisk or spirituous, like that distilled from putressed Urine, nor did it presently give a manifest greenness to Syrup of Violets; but in a solution of Sublimate, it had the same effect with Spirit of Urine or a Volatile Salt. And having mixed some of it with Syrup of Violets, spread all night upon white Paper, and another parcel of it with slings of Copper, the former in the Morning was turned green; and the latter was so far dissolved, as to leave a large blue stain upon the Paper.

One part of Salt of Tartar being disloved in eight Parts of Serum of Human Blood, and stirred over a gentle Heat, it was not turned red by it as Milk is. That Blood will be coagulated by Heat in a short time into a kind of Gelly, is a common Observation. But having put Spirit of Human Blood into Serum, and kept it a convenient time over a fire, the Volatile Alkaly seemed to make the coagulation more slow. And this effect was more considerable, when we tryed another parcel of Serum with Salt of Tartar instead

The fourth Part, containing the History of the Spirit of Blood, begun.

of Spirit of Blood.

B Efore I proceed to the Titles belonging to this Part of the History, it will be requisite to advertise,

First,

first that the Spirit made use of in the fol-Tryals and Observations, was drawn Human Blood without any Sand, Clav. other Additument; and that the full Di-Mations were performed in Retorts placed Sand, care being taken that the Vessels ald not be too much filled, because Blood not well dryed is apt to swell, and pass into henck of the Retort, if not into the Receiver.

Secondly, It is to be observed, that the lood we made use of, was such as was drawn People, who frequently bleeded by way

prevention.

Thirdly, There is fo great a Cognation beix the Spirit, and Volatile Salt of Human lood, that the latter feems to be the former by in a dry form.

Lift of Secondary Titles, concerning the Spirit of Human Blood.

I Whether Human Blood may be fo or- of the Hiby Fermentation or Putrefaction, as flory of Huut in Distillation, a Spirit either Urinous or man Blood Vinous may ascend before the Phlegm.

II. Whether Spirit of Human Blood be rally any thing, but the Volatile Salt and .

Phlegm well commixed.

III. Of the Species of Saline Bodies, to which Spirit of Human Blood is to be refer-

IV. Whether Spirit of Human Blood be differing from Spirit of Urine, and other Spirits are called Volatile Alkalies.

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V. Of the quantity of Spirit contained in Human Blood, whether accompanyed with Serum or dryed.

VI. Of the specifick Gravity of Spirit of

Human Blood.

VII. Of the Odour, Tafte, Colour, transparency and consistency of the Spirit of Human Blood.

VIII. Of the diffolutive power of the Spirit

of Human Blood.

IX. Of the Tinctures that may be drawn by Spirit of Human Blood.

X. Of the coagulative power of the Spirit of

Human Blood.

XI. Of the precipitating power of Spirit of

Human Blood.

XII. Of the Affinity betwixt Spirit of Human Blood, and fome Chymical Oyls and Urinous Spirits.

XIII. Of the relation betwixt Spirit of Hu-

man Blood and the Air.

XIV. Of the Hostility of Human Blood with Acids, whether in the form of Liquors or Fumes.

XV. Of the Medicinal Virtues of Spirit of

Human Blood externally applyed.

XVI. Of the Medicinal Virtues of Spirit of Human Blood internally given in Pleurifies, Head-achs, Coughs, Fevers, Scurvies, Cachexies, Dropsies, Fits of the Mother.

XVII. Paralipomena, and promiscuous Experiments and Observations concerning the

Spirit of Human Blood.

TITLE

TITLE I.

Whether Human Blood may be so ordered by Fermentation or Putrefaction, as that in Distillation a Spirit either Urinous or Vinous may ascend before the Phlegm.

Onfidering that Fevers have been looked upon to proceed from a Fermentation in the Blood; and likewise, that Human Urine which ath a great Cognation with Human Blood, will not whilst fresh afford a Spirit, till the Megm be first drawn off; this Subject of this Title may not appear Groundless. But I not much encouraged to expect a Vinous or odent Spirit from Human Blood, nor am I ire there is any fuch thing as Fermentation h Human Blood. And on this occasion I shall ad, that having once kept Blood Hermetical-I fealed up in a Glass for twelve Months, when it came to be opened, it smelled so offenfively, that we could not make any tryal on it; and another time having digested, a pretty large Vial Hermetically fealed fome Sheeps Blood; when it had been a good while the digestive Furnace, it suddenly broke with a considerable noise, and blew off the long neck of the Vial. And here, to what both been laid down, I shall add, That some Ounces of Serum of Blood being added to a fourth Part of Raisins of the Sun Stoned, and tept in a Glass, in a warm Room for several days; the event of this tryal was, that with-Ii3

in a few Days the Raisins began to emerge, and whilst they floated, yielded a considerable quantity of springy and permanent Air; from whence it appeared, that there had been some Degree of Fermentation. But when this Serum came to be distilled, tho' it did not stink as if it had been putrissed, yet the Spirit which first ascended, tasted not like a-Viscous Spirit, nor like a meer Phlegm. Whether the Fermentation observed in this Liquor, depended on the whole Serum, or only on the Aqueous Parts distinct from it, I shall leave to Experience to determine.

would so open the Texture of Blood, as to make it part with its Spirit more easily, and before the Phlegm, I kept a quantity of Serum for that purpose, four times as long as was sufficient to make Urine part with its Spirit before its Phlegm, but the Liquor which came over by a gentle heat, had but little strength either in Smell or Taste; nor would it readily turn Syrup of Violets Green; yet like a Volatile Alkaly, it would soon turn a Solution of Sublimate in fair Water, into a White, Opacous, and almost Milky Liquor.

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TITLE II.

Whether Spirit of Human Blood be really any thing but the Volatile Salt and Phlegm well commixed.

OR feveral Reasons I am inclined to believe, that the Spirit of Human Blood is totally composed of a Volatile Salt, and a Phlegm which is not fo pure and Elementary, but that ome Particles of Oyl, and others of Salt, may mixed with it; and whether by frequent Redifications this Phlegm may be rendered Homomeous I much question, since I am not sure, on that in frequent Distillations, some Particles of the Fire mny be from time to time ociated with the Liquor; and even in the fift Distillation, the Fire uniting with the Lipor, may form one different from the Inredients or Principles of the Body; and I have bend that Woods afford by distillation, a Liquor which is not an Oyl, nor an Acid, or an Alkaly, and yet no true Phlegm, but an Adiaberous Liquor. And on this occasion to shew, That the Composition of a Body may as well be made known by investigating the way of generating or producing it, as by that of Analyling or resolving it; I shall add, that having diffolved as much Volatile Salt of Human Blood in distilled Water, as the Liquor would take up, and then having distilled it in a convenient-In shaped Vessel, with a regulated degree of Heat, the Distillation afforded us such a Li-

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quor as was desired, since by Smell and Taste it appeared to be a good brisk Spirit of Human Blood. And this Experiment was again repeated with the like success.

TITLE III.

Of the Species of Saline Rodies, to which the Spirit of Human Blood is to be referred.

THO' it be generally allowed that Saline Spirits are of two forts, yet it may not be amiss to add, That some of them are Acid in Tafte, as Spirit of Nitre, Vitriol, &c. O. thers are rather like common or lixiviate Salts; and their different Effects and Operations are much less alike than their Tafte, for upon their mixture, there ensues a manifest conflict, and usually one will precipitate the Bodies, the other will dislolve. And amongst Salts called Alkalies, some are fixed in considerable Degrees of Fire, and others, who take Acid and Alkalies for the true Principles of mixed Bodies, call the one Fixed, and the other Volatile Alkalies. And tho' I, who question this Doctrine, often call the Salts made by Combustion, simply Alkalies, or lixiviate Salts, and those that ascend, sometimes Vrinous, and fometimes Volatile Salts, yet fince the Names of Fixed Alkalies and Volatile ones are in request now, I shall now make use of them in that Sense.

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These Things being premised, I shall promed to observe, that notwithstanding that some Phylicians and Chymists ascribe Digestion to a Acid Ferment in the Stomach, yet the Spiit of Human Blood is referrable to that Claffis, which many call Volatile Alkalies, fince it generally performs what Volatile Alkalies are faid to do; for it will ferment with Acids, mrn Syrup of Violets Green, and precipitate Solution of Sublimate in common Water.

Were I fure that the Ferment of the Stomach were Acid, I should be apt to believe, that the Blood retains fomething of Acidity in it; but yet that would not be an Argument why I should not refer the Spirit of Human Blood to the Class of Alkalies, because so few Acid Particles would either be destroyed by the Alkalizate ones, that are fo abundant in the Spirit, or at least they would be so very much predominant as to give us Reason on their account to denominate, the Mixture Alkalious. As if fome drops of Spirit of Vinegar were mixed with stale Urine, they would be either depriv'd of their Acidity by some Particles of a contrary Nature, or be fo overpowered by the Fugitive Salts they abound with, that the Mixture might well be referred to the Classis of Volatile Urinous Salts.

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TITLE IV.

Whether the Spirit of Human Blood be differing from Spirit of Urine, and other Salts called Volatile Alkalies.

PON this Occasion I shall offer, that not to intimate that a Body may have many fimilar Qualities, in respect of another Body, and yet diftinct Operations on a third Substance: I say, not to intimate that, there may be a confiderable difference betwixt Volatile Salts or Spirits, as they are commonly prepared, and when prepared as they may, by reiterated Rectifications, and other ways of Depuration by a dextrons Chymift, to bring them to a greater degree of Purity and Simplicity; a greater degree I say, because it may be difficult to bring them to an absolute Purity, fince unheeded commixtures may be made, upon the Account of some Corpuscles of Fire with the Body they work upon.

And that there is a manifest difference betwixt Spirit of Human Blood and other Alkalies, as Spirit of Urine and Harts-horn, is evident to several People who, tho they abhor the Odour of Spirit of Blood, yet they will with Pleasure hold their Noses a great while over Spirit of Urine and Sal-Armoniack. And tho from a due proportion of Spirit of Urine or Sal-Armoniack with Spirit of Salt, I have got a Salt which shoots into the shape of that of Urine or Sal-Armoniack

I have feldom, if ever, obtained a Salt of he like shape from a Mixture of the Spirit of Homane Blood with that of Common Salt. for the upon an Evaporation of the superfluous Moisture, the Salts would coagulate together, set the Concretion feemed confused, and not of the Regular shapes of those Salts, resulting from a Mixture of the Spirit of Sea-Salt with Urinous Spirits. And Helmont tells us, that the Spirit of Human Blood will cure Epilepfies, which Spirit of Urine will not do.

TITLE V.

of the Quantity of Spirit contained in Human Blood, whether accompanied with its Serum, or dryed.

HIS is not easie to determine, fince fome Mens Blood is much more Phlegmatick than others, or more Serous, which may of it felf be more Spirituous, according to the Complexion, Age, Sex, &c. of the Per-

fon that Bleeds.

Twelve Ounces of Healthy Human Blood, afforded us feven Ounces and a half of Phlegm, and consequently about Four Ounces and a half of dry stuff. And having distilled in a Retort, in a Sand Furnace, feven Ounces of well dryed Blood, we obtained about an eighth part of Spirit, which, tho' not rectified, left in the Receiver and Viol I kept it in, a good deal of Volatile Salt undissolved,

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which a Phlegmatick Liquor would not have done. And if Spirit of Blood be but a Salt and Phlegm united, We may well funpose, that Human Blood yields a far greater Proportion of Spirit than this, fince from the feven Ounces of dryed Blood, we obtained about five Drachms of Volatile Salt, which had it been united with a due quantity of Phlegm. it would probably have afforded us near two Ounces more of a Liquor deserving the Name of Spirit.

TITLE VI.

Of the Confistence and Specifick Gravity of Human Blood.

Compact Body, which in the Air weighed fifty eight Grains, and in Water weighed fix Grains and 1, in rectifi'd Spirit of Human Blood weighed but five Grains and ;; and what was confiderable, was, That a piece of Amber would not subside to the Bottom, but kept floating upon the Top, and if plunged into it, would emerge again.

As for the Degree of the Fluidity of the Blood, or its immunity from Tenaciousness, tho' divers other Alkalizated Liquors, as Oylof Tartar per denglium, fixed Nitre resolved per deliquium, a Solution of Pot-Ashes, are sensibly unctuous, and but languidly fluid, yet I obferved that Spirit of Human Blood did not appear more Unctuous than common Water.

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and whereas it is commonly found, That a Liquors are more spirituous, so the Bubles miled by Agitation, soonest disappear; I have observed that the Spirit of Blood was almost a soon clear of them as Spirit of Wine; and when some Drops of it were let fall, they manifestly appeared less than Drops of Water.

To discover the subtlety of the Parts of Haman Blood, we so prepared common Water, by Infusions made in it without Heat, that by putting one fingle Drop of our Redified Spirit of Human Blood into ten Ounces and four Scruples of the prepared Water, and lightly shaking the Viol, there appeared throughout the Liquor a manifest Colour, whereof no Degree was discernible before; fo that it dispersed it self through a thousand times as much Water, and produced a manifeft Change in the Colour of it : And tho' this Computation is made upon the common suppoftion that a Drop of Water weighs a Grain, yet tho' it weighs more a little, the Difference is recompensed, fince having dropped ten Drops of common Water into a common Ballance well adjusted, and having likewise dropped ten Drops of this Spirit, we found that the last were not only less in bulk, but lighter, fince they weighed not above four Grains, fo that the Proportion to which it extended it felf, may be faid to be as one, to betwixt 4000 and 5000; and this fubtlety of the Parts of the Spirit of Human Blood will appear to be yet much greater, if we consider, that some Part even of this Drop must needs be Phlegm.

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TITLE VII.

Of the Odour, Tafte, Colour, and Transparency of the Spirit of Human Blood.

"Hat the Spirit of Human Blood is in re spect of some Liquors potentially Cold. fince it refrigerates them, and with reference to others potentially Hot, fince being mixed with them it renders them Hot, may appear from the following instance ; for having put the lower end of an Hermetically sealed Weather-Glass into a flender Cylindrical Glass, we poured as much moderatly strong Spirit of Blood into it as covered the Ball, and then dropped on that Liquor some good Spirit of Salt, upon which enfued a conflict accompanyed with a Noise, Bubbles, and Heat, which made the Spirit of Wine prefently ascend above two Inches and a half; which Experiment feems to be the more remarkable, because several other Volatile Alkalies being mixed with Acids, produce a notable degree of coldness; and whereas I had several times found by Tryal, that the Spirt of Verdigrease would, with Volatile Salt of Sal-Armoniack or Urine, produce a real coldness. This Spirit of Verdigrease being mixed in the small Cylindrical Glass, with Spirit of Blood moderately strong, not only produced a hissing Noise and store of Bubbles, but an actual Heat, upon which the Liquor in the Thermoscope afcended

aftended above an Inch and a half, tho' both the Liquors employed amounted not to above two foonfuls.

TITLE VIII.

Of the dissolutive power of Spirit of Human Blood.

THAT this Spirit is not only a good Medicine for several Diseases, but is also a good Menstruum, will appear from the following instances. And first, having poured Spirit of Human Blood upon Crude Copper, in about a quarter of an hour the Liquor was tinged blueish, which colour grew higher and higher, till in some hours it was deeply Ceruleous. And to this I shall add, that having dropped a drop or two of Spirit of Blood upon a piece of bright Copper, within about half a minute of an hour, the Verge of the moistened part of the Surface appeared blueish, and in a little time after, the rest of the wetted Part acquired a fine Azure.

Having poured Spirit of Blood upon filings of Zinke or Spiltre, it presently began to work manifestly in the cold; and when assisted by a little Heat, it disloved the Zinke briskly, and not without producing store of bubbles, being also a little discoloured by the operation

of this Experiment.

Having put a piece of clotted Blood, which had been exposed to the Air, into a slender

Vial of clear Glass, and then poured on a little rectified Spirit of Human Blood, and shook the Glass a little, the blackness of the superficial part of the Blood presently disappeared, and became a florid Scarlet, and the Liquot was tinged with a fairer red, and from a fuccession of bubbles passing from time to time out of the cold into it, feemed to work somewhat like a Menstruum, but in a little time after the Blood was degenerated from its former colour to a little more dark one. But another clot of Blood, one fide of which was red and the other black, being put into the Vial, and Spirit of Blood poured upon it, the red fide had its colour improved, but the other continued black and dirty. And I once preferved twelve drachms of Blood in two of the Spirit of Blood, and found that twelve months after it remained fair and florid, and little less than totally fluid; and when the Vessel was opened there appeared little fign of Putrefactis on, but only a small clot was fastened to the bottom, the rest passing readily through a strainer; so that the Spirit seemed to have a great embalming Virtue, fince it was able to preferve fix times its weight of a Body fo apt to putrefie: But to what hath been observed, I shall add, that having comitted the Mixture to Distillation, the first Liquor was a kind of Phlegm, which was succeeded by a Spirituous Liquor and Volatile Salt in a dry form.

Having poured some of our Spirit upon filings of Iron, where they were not in the least Rusty, and kept them together a while in digestion, we found, as we expected, that Li-

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quer by working upon them had produced a light substance, something paler than a Crocus, and there appeared likewise in the Liquor good store of thin Plates, which after a gentle Agitation, being held against the Sunbams, exhibited the colours of the Rain-Bow very vividly; but the taste of the Liquor appeared not at all Martial.

TITLE IX.

Of the Tincture that may be drawn with Spirit of Human Blood.

Spirit of Blood being put upon Saffron prefently acquired a yellow colour; and from Tu merick, a Tincture like a folution of Gold, which may doubtless prove a good Medicine in the Jaundice; and some of this Spirit being put upon powder of Blood, it presently extracted from it a colour as red as that of french Claret, but when I made use of another parcel of Spirit well rectified, I found that it extracted not a Tincture so soon; and after several hours the colour it obtained was brown, which in some hours after was heightned into redness, and in a longer time it became almost as red as the former Tincture.

To shew that Spirit of Human Blood may extract Tinctures out of the hardest Bodies, we put filings with it into a small Egg, and kept them all night in digestion in a moderate Heat; and the next day we found the Liquor

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tinged with a deep brownish red; and those filings which stuck to the fides of the Veffel and were above the Liquor, were turned by the Exhalations of this Spirit into a yellow Crocus: But the Mixture being kept some days longer in the same Vessel, the colour of it was grown Opacous, and appeared to be black when it was looked upon in a confiderable bulk; but it feemed of another colour when looked upon as it was spread thin upon white Paper. Some of this Ticture being poured upon an infusion of Galls, it would not make it of an Inky colour, nor was the precipitate, which presently fell to the bottom, of an Inky colour. From which Experiments it appears, that it is unfafe either to suppose, that if Chalybeates be dissolved in the Body, it must be by some Acid Juice, or to conclude, that if Steel be diffolved by the Liquors of our Bodies, they, must be ex predominio Alkalizate, fince a Liquor that is very different from Acids dissolves it; but without touching further upon this account, I shall rather commend it to the confideration of Phylicians, to pitch upon some other method of explicating the effects of Chalybeates upon Human Bodies, and whether martial Medicines may not be made use of, which are prepared by Volatite Alkalies, instead of Acids.

Spirit of Human Blood being kept in digestion with powder of Amber, it extracted no considerable Tincture, but whether the fault was in the fineness of the Amber, or the weakness of the Spirit, I shall leave undeter mined.

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Some Spirit of Human Blood being put upon some of that Gum called Seed-Lac soon became tinged, which I supposed to proceed from a superficial colour of some Parts of the Gum, proceeding from some adhering Blood of the little winged insects, who by their bitings occasioned this Gum, upon the twigs of the Trees where it is found; so that the colour seems not to be given by the Gum, but the Blood of those Animals, and may probably be a good solvent Meditine, since most of the insects used in Physick consists of Parts very subtle and penetrating, and of considerable Efficacy.

TITLE X.

Of the Coagulating power of the Spirit of Human Blood.

Highly rectified Spirit of Human Blood, being well mingled by shakeing it with a convenient quantity of Urinous Spirits, there will presently ensue a Coagulation or a concretion of Parts, either of the whole Mixture or Portion of it, into corpuscles of a Saline form, which cohering loosely together make up a mass of a fluid and consistent soft temper; in which form it will continue in a cool place several months.

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TITLE XI.

Of the Precipitating power of Spirit of Human Blood.

I T hath a power of Precipitating, as other Volatile Spirits, most Bodies dissolved in Acid Menstruums; I say most, because there is no need this rule should be general, or hold when the Body is of such a Nature, that it may be as well dissolved by an Acid as an Alkaly; and that there are such Bodies appears, since Spirit of Human Blood will dissolve both Copper and Zink, which may be likewise dissolved by Aqua Fortis and other Acid Menstruums.

But that this Spirit will precipitate other Bodies dissolved in Acid Menstruums, I am convinced by feveral tryals made on red Lead dissolved in Vinegar, Silver in Aqua Fortis, Gold in Aqua Regia, and Tin dissolved in an appropriated Menstruum, and several other Bodies. And out of a Solution of common Salt made in Water, we could readily precipitate with the Spirit of Blood, a Substance which looked like a white Earth, and fuch a Substance I obtained in a far greater quantity, from that which the Salt-makers call Bittern, which usually remains in their Salt Pans, when they have taken out about as much Salt, as would coagulate in figured grains. This Spirit of Human Blood does likewise precipitate a Solution of Dantzik Vitriol in Water, but that Solution is not a total one.

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TITLE XII.

Of the Affinity between Spirit of Human Blood, and some Chymical Oyls and Vinous Spirits.

HAT there is an Affinity betwixt Spirit of Human Blood, and Spirit of Wine, appears, fince we have formerly observed that being put together, they will concoagulate, and continue united a long time; and tho' a rectified Spirit of Wine will not draw a Tindure from Blood, yet Spirit of Blood will. But as for Lixiviate Liquors fuch as are made of Salt of Tartar, fixed Nitre, &c. we find not that they will strictly affociate with it. Spirit of Blood readily mixes with that Adiaphorous Spirit formerly mentioned; but dephlegmed Spirit of Blood mixed by a itation with its Oyl, will presently separate again, tho' with Spirit of Wine it will permanently mite, tho these two Liquors belong to a different, viz. the one to the Animal, and the other to the Vegetable Kingdom.

With the essential Oyls of Aromatick Vegetables, the Spirit seems to have a greater Assimity; for an equal proportion of this Liquor, and of Oyl of Aniseeds, drawn in an Alembick per Vesicam, being shaken together, they made a soft or Semissuid coagulation, which continued in that form for a day or two; and would probably have longer done so, if I

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had not had occasion to proceed further with it.

To shew that Spirit of Human Blood may either communicate some of its saline Parts to essential Oyls, or work a change in them; I digested a while in a Glass with a long neck some rectified Spirit of Human Blood, with a convenient quantity of Oyl of Aniseeds drawn in an Alembick, and found that the Oyl grew coloured of a high yellow, and afterwards attained a high redness; which may afford us a hint of the cause of some changes of colour, that are produced in the Liquors of the Body.

To take off the ftinking quality of Human Blood, and to render it more grateful, we mixed with it in a Glass about an equal quantity or half as much Oyl of Aniseeds, and having shaken them together in the Glass, we placed it in a furnace with a gentle Heat, by which means the slight Texture of the Coagulum being disloved, part of the Oyl appeared floating upon the top, whence being separated by a Tunnel, the Liquor was whitish and without a stinking smell; it smelling and tasteing strong of Aniseeds, tho' the saline Particles retained a considerable degree of their brisk and penetrating taste.

Another way I took to deprive Spirit of Human Blood of its offensive smell was, by employing a Medium to unite it with essential Oyls; for having dissolved an eighth part of Oyl of Aniseeds in highly rectified Spirit of Wine, and added an equal quantity of Spirit of Human Blood, and upon a convenient agitation we suffered the Mixture to settle a considera-

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ble time, after that it appeared, that some of the Oyl fwam in drops diffinct from the other Liquors, which confifted of a Mixture of the two Spirits impregnated with a few particles of Oyl which they had detained. This Liquor abounded with little Concretions made by the Congulation of the Sanguineous and Vinous Spirits; which by a gentle Heat were sublimed in the form of a Volatile Salt, to the upper Part of the Glass; and this Salt had not only a much less penetrating Odour, than the meer Volatile Salt of Human Blood, but had quite lost its stink, and yet retained a considerable quickness, and something of the scent of Anifeeds; and the remaining Liquor was likewise deprived of its ill smell, and moderately imbued with that of the Oyl.

To try whether there would be any Affinity between our Spirit, and the highly rectified Oyl of Petroleum, I shaked a convenient quantity of them together in a new Vial, upon which they presently turned into a white Mixture; and tho after a few hours the greater part of the Oyl swam above the Spirit, yet there appeared betwixt the two Liquors a good quantity of whiteish Matter, which seemed to be produced by the Union of many Particles of the Spirit and Oyl, which were most disposed to combine.

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TITLE XIII.

Of the Relation betwixt Spirit of Human Blood and the Air.

O try whether the Air will have any con-fiderable effect on the Spirit of Human Blood after Distillation, as it evidently hath on the Blood before, I spread thinly upon a piece of white Paper some small filings of Copper, and wetting them well without covering them quite over, with a few drops of Blood; by that means they being well exposed to the free Air; the Action of the Liquor was fo much promoted, that within a minute or two it did even in the cold acquire a blueish colour; and in fewer minutes than one would have expected, that colour was fo heightned as to become Ceruleous; but another parcel of the same filings being put into a Vial, the intercourse of the Air being excluded, the Liquor would not in some hours acquire so deep a colour.

Having in a clear Cylindrical Vial of about an Inch Diameter, put more filings of Copper than was requifite to cover the bottom, and poured so much Spirit of Blood upon them as rought about a fingers breadth above them, it in a few hours acquired a rich colour, which after a day or two began to grow more faint, and afterwards gradually declined, till it was almost lost; yet the Liquor was not altogether limpid or colourles, as I have often

hed it with Spirit of Urine or Sal-Armoniack, and these remains of blueishness I attributed to the effects of the Air included in the Bottle, with fo small a quantity of Liquor. And tho' I thought it not impossible, but that length of time might destroy it's blueishness, yet unstopping the Vessel, I observed, that in two minutes of an hour, the Surface of the Limor where it touched the fresh Air became Ceruleous; and in a quarter of an hour the whole Body of the Liquor had attained a deeper colour than that of the sky, which colour grew fenfibly paler again when the Vial was stopped : But one thing I must add is, that I have found the Experiment to succeed with fome Analogy, when another Volatile Spirit hath been made use of, in which there was no Volatile Salt of Human Blood; but the Experiment being repeated the Air produced a green and not a Ceruleous colour, which makes me suspend my Judgment till satisfied. by further experience, whether the event of the former tryal depended on any Affinity of the Spirit with Blood or not. And here I shall add, that a parcel of Spirit of Human Blood being kept in Vacuo Byliano, when the Air was pumpt out, it afforded fewer and less bubbles than an equal quantity of common Water.

TITLE XIV.

Of the Hostility of the Spirit of Human Blood with Acids, whether they be in the form of Liquors or Fumes.

T exercises its Hostility against more than one fort of Acid Spirits, as Spirit of Salt, of Nitre, Spirit and Oyl of Vitriol, Aqua Fortis, Aqua Regis,&c. And not only against Factitious but natural ones, as the Juice of Lemons, upon its Mixture with which there presently ensued a great commotion with noise. But there is not only an Hostility evident betwixt the Parts of these Liquors, but also their Effluvia; for if Spirit of Salt of Nitre be put into a Vial somewhat wide mouthed, and Spirit of Blood rectified into another, when these Liquors are held near one another, their invisible Emanations joyning together will form a manifest Smoak.

Some pure Volatile Salt of Human Blood being just satiated with Spirit of Nitre, we slowly evaporated the superfluous moisture, which being done, we took the compound Crystals which the Mixture afforded, and put it into a Bolt-Head with a slender and a long neck, and then adding to it a convenient quantity of Salt of Tartar, and as much distilled Water as made the Mixture Liquid enough, the Salt of Tartar detained the Spirit of Nitre, and a good proportion of the Volatile Salt ascended

aftended in a dry form to the neck of the

Spirit of Blood and Nitre being mixed together, there enfued a conflict, in which thick white fumes rose plentifully, and circulating in the Vessel, ran down the sides of it in a white fream; untill the fumes ceased to rise again, the Mixture in the mean time appearing reddifh. Being fetled and feeming to have been to discoloured by a fattish Substance, we put to it a little rain Water, and having by filtration separated the Faces, and slowly evaporated the thus clarified Liquor, the faline Parts hot into Crystals like those of Salt-Petre; but after a while seemed yellow, as if tinged with the Oyl. N. Tho' on several occasions the Spirit of Blood appears Oyly, yet I not long fince disfolved another parcel of Blood, whose Liquor was clear and limpid a year after.

Some of the before mentioned Crystals being put upon well kindled Charcoal, presently melted and burnt away like Salt-Petre, but the slame seemed not so halituous, and differed in colour, being not at all blue but yellow; and after the Desiagration ceased, there remained upon the Coal a lump of dirty coloured matter, which had scarce any taste, nor was that little it had Alkalious. This brittle Substance being held in the slame, became red hot without any sensible imminution, and so it did upon a

live Coal.

TITLE XV.

Of she Medicinal Virtues of Spirit of Hu. man Blood outwardly applyed.

CINCE we meet not with any Acid Sub-I ftance, except in the Pancreatick Juice of a found Person: And since the fixed Salt of Blood does much resemble Sea-salt, whether its Spirit be Acid or no; and fince feveral Parts of the Body whether Solid or Liquid, afford a Liquor impregnated with store of Volatile Salt; it is not amifs to think that the Spirit of Human Blood, may have confiderable effects in several Diseases, even when externally applyed. And that Spirit of Sal-Armomiack hath been found successful in affisting several People in Apoplexies, Epilepfies, &c. when applyed to or put up the Nostrils, it's confirmed by the experience of several learned and able Physicians; and upon the like reason I prepared a Volatile Salt sublimed from a compound Salt, obtained from Spirit of Blood fatiated with Nitre. And for a like purpose, to bring over the Saline Part of Blood in a liquid form, we mixed two Parts of dryed Blood with three of Spirit of Blood, and distilling them with a pretty strong fire, we obtained a pretty deal of Spirit, unaccompanyed with any Volatile Salt, in a dry form; and this Spirit feemed to have a stronger taste and finell before rectification, than Spirit of Human Blood prepared another way had after rectification;

and

and had we made use of more Lime, I question not but that we should have obtained a more piercing Spirit, since it would have retained more of the Oyl and the superfluous moiture.

And on this occasion I shall add, that I have often found Head-aches cured by the separated application of Spirit of Human Blood; which is likewise good in Hysterick and Hypochondriacal Cases, and in fainting Fits; and if the smell of it makes it too nauseous, that may be corrected according to the method already laid down in this Chapter, to which I shall add, that a few drops of Oyl of Rhodium, being dissolved in Alcohol of Wine, if that be mixed with Spirit of Human Blood, it will give it a very grateful and odoriferous smell.

And here I shall add, that Medicines made of Amber have been found successful not only in Convulsions, and other Distempers of the Genus Nervosum, but the Tincture of it in Spirit of Wine, hath proved successful enough in Diseases both of Men and Women. And this Tincture may not inconveniently or unfuccessfully be added, to correct the Odour and increase the Virtues of Spirit of Human Blood; and the Oyl of Amber will not mix readily with Spirit of Wine, yet if they be shaken together and left to fettle at leifure, tho' they fettle in diftinct maffes, yet the Spirit would even in the cold extract a high and a yellow Tincture, little different from the Oyl it felf, which may be mixed with the Spirit of Blood, till the smell of the Amber be predominant.

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To what hath been faid of the external use of Spirit of Human Blood I shall add, that if the Oyl in these Mixtures should be too much predominant, it may be easily separated by runing it through a Tunnel, whose Orifice at the bottom is formed fo small and sharp, as to give way for the Spirit to run off first, which may when thus separated be kept in a distinct Vessel. And fince if the Vinous Spirit be fufficiently rectified, there will by the Coagulation of the Saline and Urinous Parts, be produced a kind of Salt, you may either pour the Liquid part into another Vessel, and then use them separate, or else separate the Salt by fublimation in a dry form; and Spirit of Human Blood thus separated will have a fragrant brisk and piercing Odour. But,

To conclude, this Spirit is not only good in respect of the Virtues ascribed to its scent, but it may be good likwise when used as a fomentation, as Spirit of Sal-Armoniack hath been effectual in removing the Pains of the Gout, and in the Erifipelas. And fince upon the account of its Alkalizate Nature it may be good to correct Acidities, it may be for that purpose made use of both by Physicians and

Chirurgeons.

TITLE XVI.

Of the Medicinal Virtues of Spirit of Human Blood inwardly used.

Have been long apt to think, that the fame peccant matter may produce feveral Diftempers as its effects are diversified, partly by its greater or leffer quantities, as well as more or less active qualities, and partly by the particular Natures, or Structures, and Scituations of the Parts that it invades; which feems to be favoured by the frequent Metastafer of Morbifick matter in several Distempers, fince the fame Acid or sharp Humours sometimes occasion a Colick, sometimes after that a Palfey, at other times a Cough, a flux of the Belly, an Opthalmia, a Violent Head-ach, Convulsions, &c. As the peccant Humour falls upon this or that part, upon which account one or two Medicines may be able to cure several Distempers, especially if endewed with any variety of active Virtues; and upon these grounds I am inclined to believe, that the Spirit of Human Blood may be a good Remedy in feveral internal affections of the Body; and indeed Volatile Alkalies in general have been fo prosperously made use of in Phylick, fince the year 1656 as to invite feveral Physicians to employ them instead of other Medicines, which clog and weaken the Patient, and want feveral advantageous

tageous qualities, which may be found in Vo-

latile Alkalies,

And indeed Spirit of Human Blood mortifies Acid Salts, which occasion several Difeases: It is likewise a great Resolvent, and fit to open Obstructions which produce not a few Diseases; it is also Diaphoretick and Diuretick, and able to discharge several noxious Salts, and to expel feveral Malignant and Contagious Particles of matter. It relists Putrefaction and Coagulation; and gives a briskness and Spirituousness to the Blood, which promotes free Circulation upon which account it Cordial and an is a good Antidote against some Poysons: It is very friendly to the Genus Nervosum, and to cure its Diftempers, and Balfamick in some fort of Albams, it neither causes great evacuations, nor does it clog the Stomach; or is disadvantageous in any manifest qualities. And it may likwise be very good in such cases as Spirit of Sal-Armoniack hath been found successful in. Helmont commends it in Epilepfies, which he fays, it will cure in Adult Persons: And I have known it cure an inveterate Consumptive Cough, and a very bad Head-ach, which had a long time baffled very eminent Phylicians. But besides the Virtues it hath when simply used, its Virtues may be enobled and divertified by a long digestion, or frequent Cohobations of the Spirit with the Oyls, Salt or Phlegm of the same Concrete; or, by uniting it with Acids, as Spirit of Nitre, or Vinegar; Verdigreafe, Oyl of Vitriol,

Viriol, &c. either used in a Liquid form, or when reduced by evaporation into Crystals.

Or the Virtues of it may be enobled, by usting our Spirit with Metalline Solutions, as dGold, Silver, or Mercury; and with Solutions d Mintum made with Spirit of Vinegar; by a Mixture of which Liquor and a flow evaporation of them, I have obtained finely shaped

Crystals.

Or, again either by uniting with it Sulphur opened with Salt of Tartar; or by dissolving in it Metalline Bodies, as Copper, Zinke, and fron. Or by adding about a double weight of Acohol of Wine; for these Liquors being haken together, will in a very great measure coagulate into a Salt, which will retain a considerable degree of quickness and penetrancy. And why fuch Salts as these should not be efficacious I fee no reason, since such a kind of Mixture, tho' made with another Urinous Spirit hath had extraordinary effects in Fevers, nor is the Liquor this Salt leaves behind useless in Medicine when well dephlegmed.

But this Spirit may be rendered still more; commodious, if impregnated with essential Oyls; and by that means several Oyly Volatile Salts may be produced, which may be ufeful in peculiar Distempers, as those Oyls respect this or that part in their Medicinal Virtues.

CHAP.

CHAP. X.

An Appendix to the Memoirs for the Natural History of Human Blood: Containing, first, particulars referable to the second Part of the foregoing History.

EXPERIMENT L

Aving caused twelve Ounces of dryed Blood to be carefully distilled, the Substances obtained from it, were of Volatile Salt and Spirit together five Ounces; the Liquer poured off from the wet Salt being thirteen Drachms, fifty four Grains, fo that the Salt was three Ounces, two Drachms, and fix Grains; of fetid Oyl there were two Ounces; of Caput Mortuum four Ounces, and two Drachms; fo that about fix Drachms of the whole was confumed in the Operation. The Caput Mortuum being calcined yielded but fix Drachms and a half of ashes, the fixed Oleaginous Parts being confumed by the accension; the colour of the ashes was reddish when cool, tho' in the fire they appeared white as foon as the Oyl was confumed, these ashes being turned into a Lixivium, afforded five fcruples of white fixed Salt, besides a little which got into the contiguous Sand, which being recovered by Water, and reduced to a Salt made a scruple more. So that there remained for the Terra Damnata fourteen Scruples and a half, which is a good deal above twice

the weight of the Salt; whence it appears, that the pure fixed Salt is but between the fifty feventh and fifty eighth part of dryed Blood, and therefore probably amounts to no more then about the 170th part of the mass of Blood; and the fixed Earth is to dryed Blood as about nineteen and about a half to one.

EXPERIMENT II.

A parcel of Blood weighing ten Ounces and leventy three Grains, being flowly distilled to dryness in a Head and Body on a digestive Furnace, afforded of Phlegmatick Liquor feven Ounces, two Drachms, and forty feven Grains; and of Caput Mortuum or dry Substance two Ounces, two Drachms. This pulverable matter being distilled in a Retort by degrees of fre yielded two Drachms, forty eight Grains of Oyl. The Spirit being poured off, the Salt weighed but forty eight Grains, and the Salt being washed out with the distilled Water, we obtained thence by Sublimation into the neck of a Glass-Egg one Drachm, five Grains of dry Salt. The Capul Mortuum weighed fix Drachms, twelve Grains, which being carefully calcined yielded two Scruples and four Grains of ashes; which were red. and these being elixivated afforded eighteen Grains of Salt, besides the remaining Earth, which is of a red colour with an Eye of Purple.

Parti-

Particulars referrable to the Primary Title of the Natural History of Human Blood.

EXPERIMENT I.

Spirit of Vinegar put upon Blood, turned its red colour of a dark or dirty colour.

EXPERIMENT II.

Juice of Limons poured upon the superficies of Blood, impaired its florid colour.

EXPERIMENT III.

Juice of Oranges changed Blood less than

EXPERIMENT IV.

The black part of clotted Blood exposed to the Air, presently became of a pleasant and florid colour.

EXPERIMENT V.

Spirit of Sal-Armoniack dropped upon black clotted Blood, presently rendered it florid, but not so much as the open Air.

EXPERIMENT VI.

Fixed Alkalies or lixiviate Salts refolved per Deliquium, turned it red, but not fo florid as the Urinous Spirit.

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EXPERIMENT VII.

The Juice of Scurvey Grass fresh drawn, inclined the black Surface of clotted Blood to redishness.

EXPERIMENT VIII.

Blood being closed up with an eighth or fourth part of Spirit of Wine about three years, was coagulated, but neither stank nor was it in the least putrified.

EXPERIMENT IX.

A fmall piece of concreted Blood being left three days in Spirit of Wine, was rendered moderately hard and friable throughout.

EXPERIMENT X.

Upon tryal we found, that an Onnce of distilled Water would dissolve at least two Drachms of Volatile Salt of Human Blood; and by the help of Heat it was able to dissolve twenty five Grains more, nor did any of this Salt shoot into Crystals upon its Refrigeration.

EXPERIMENT XI.

The aforementioned Solution being put into a Retort, to be drawn off with a pretty quick heat, we obtained a distilled Liquor, that L 1 3 contained almost all the Volatile Salt, except a little which escaped in a dry form; and this Liquor being as strong as moderate Spirit of Human Blood, it may give us a hint, what proportion of a Liquor to Salt may be fufficient for fuch a Spirit. And one thing here may be worthy our notice, viz. That the Liquor which was too much impregnated with Salt, having been exposed to the Air in a frosty Night, we perceived at the bottom of the Glass a good deal of Volatile Salt shot into Crystals, tho' the Crystals that were this way obtained were fine and clear, and fome of them larger than Spangles; yet being very numerous and flicking together, we could not discover the shape of particular Grains, nor whether they were all of the fame shape, but divers of them appeared to be flat thin Plates, with fine rectilinear Angles, so that we conjectured if the whole Plates could have been feen, their broadest Surface would have been found Hexagonal, or of some Polygone figures very near of kin to that.

EXPERIMENT XII.

An Ounce of distilled Water was shut up in a Glass-Egg, with as much Salt as could be dissolved in it, and exposed to congeal in a trosty Night; but the Salt was neither congealed nor the Water, tho' afterwards it was removed into a frigorisck Mixture, which would perhaps have froze Beer, or Ale, or the weaker sort of French Wine; yet we did not perceive the least Glaciation.

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EXPERIMENT XIII.

Tho' Sea-Salt dissolved in Water renders it less subject to be froze, yet being joyned with Ice or Snow, and externally applyed, it conduces to the freezing of it. Wherefore we mixed about a Scruple of Salt of Human Blood with Ice, to try whether it would have the like effect, and accordinly we found, that a slender Pipe of Water being immersed in it, the Water in the bottom of the Pipe was froze.

EXPERIMENT XIV.

Some of the fibrous part of Human Blood, being exposed to the Air in an open and shallow Glass in a frosty Night, the next Morning it was lightly frozen, and the Surface of the Ice prettily figured with resemblances of Combs with Teeth on both sides, not much unlike Sal-Armoniack coagulated in common Water.

And not here to mention what hath been faid, by some, of the Virtues of Human Blood, I shall propose a couple of Medicines to be prepared from it, one of which may perhaps have no inconsiderable effects: The first Medicine I attempted to make, was by putting to Salt of Tartar Oyl of Human Blood instead of Oyl of Turpentine, and by stirring them long together in the open Air, to make such a saponary concretion as Matthem's Corector, which is esteemed and employed with good success by

fome London Physicians. The other Medicine I endeavoured to make, was by uniting by long digestion the Salt, Spirit, and Oyl of Human Blood into a Mixture, which some Chymists call a Clyssus.

Particulars referrable to the third Part of the History.

EXPERIMENT L

THE Blood of a young Man, when cool, having its Serum and fibrous Parts separately weighed, the latter weighed about fix Quinces, and the serous part not many Drachms from that weight.

EXPERIMENT II.

The very ingenious Mr. Hook and my felf, having often observed on the Surface of frozen Urine, figures which much resemble Combs or Feathers; considering the Affinity usually agreed on betwixt the Serum of Human Blood and Urine, we exposed some of it, strained through a linnen rag to separate the Grumous part, to the Air, in a shallow Vessel several Nights consecutively, and observed, that being froze, there appeared upon the Ice contiguous to the Air, certain figures which did not ill resemble those of conglaciated Urine.

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EXPERIMENT III

To try whether Serum as well as Urine, might not as well be made use of for invisible lat, we traced some Characters with it upon white Paper; and when they were dryed, we beld the unwritten side over the slame of a Candle, keeping it always stirring, that it might not take fire, upon which the Letters on the upper side appeared of a dark colour, tho not of an Inky blackness.

Particulars referrable to the fourth Part of the History.

SINCE according to the feveral ways of distilling Human Blood, the Spirit of Salt, &c. produced, may be considerably diversified; I distilled three Portions of Human Blood, each with a different additament.

The first which was distilled with Quick-Lime, we shall subjoyn the following account of, viz. Four Ounces of coagulated Blood, being mixed with an equal proportion of Quick-Lime, we distilled them by degrees of fire in a Retort placed in Sand, by which means we obtained a proportion of reddish Spirituous Liquor, which seemed not very Phlegmatick, together with some Oyl, the quantity of which was but small, the rest being probably detained by the Lime, and a small Portion of that little Oyl that came

over funk in the Spirit, the rest swiming upon it. The Spirit being fet in a digestive Furnace in a small Head and Body, to rectifie with a gentle Heat, the Receiver was three or four times removed ; and we observed, that the first Spirit that came over was not near fo fetid, as that which accends when it is diffilled per fe ; and the like was observed in the fucceeding Portions, the Oyl being detained behind by the Quick-Lime; the rectified Spirit was clear and colourless, and had a tafte much stronger than its smell, and so strong that it made me think fome Volatile Alkalious Parts of the Quick-Lime were carried up with it, to be satisfied of which we dropped some of it upon a Solution of Sublimate with fair Water; and on the first contact we perceived a precipitate a little inclining to yellow, as Quick-Lime in a greater quantity usually turned it : But afterwards the Precipitate appeared white, like that made with ordinary Volatile Liquors of an Urinous Nature.

Some of this Spirit put into a Glass-Egg, afforded not any Volatile Salt in a dry form, and the tryal being continued, we found, that the Spirit by the action of the fire lest its limpidness, and became muddy or troubled.

Another Portion of it being mixed with a highly rectified ardent Spirit, upon their being kept all Night in the cold, no coagulation enfued, nor could we perceive any, when it had been kept feveral hours in a moderate Heat. But the Mixture acquired a yellow colour, and let fall a pretty deal of darkish powder.

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Some of this Spirit being mixed with good spirit of Salt, they smoaked at their first meeting, but produced neither bubbles or

Another Portion being mixed with Oyl of Vitriol, there was produced a great finoak, and an intense degree of Heat without any vifible Ebullition, or any bubbles or noise, but the colour of the Oyl was heightned and grew almost red.

From whence it appears, that this Alkalirated Spirit of Blood is very different from simple Spirit of Blood; but whether upon this account it becomes a more violent, or a less fife Medicine, further Experience must difcover.

EXPERIMENT II.

Two Ounces of Tartar calcined to whiteness by an equal weight of Nitre, being distilled in a Retort in a Sand Furnace, with an equal weight of dryed and powdered Blood, it appeared that Quick-Lime acts on this occasion otherwise on Blood than other Alkalies do; for whereas the Blood distilled with that yielded a strong Spirit before rectification, and unaccompanyed with dry Salt; this Mixture afforded us at the first Distillation a weaker Spirit, but so much Volatile Salt with it as covered the whole internal Surface of the Receiver. Belides there was a manifest difference in their Caput Mortuums: And tho' the Spirit drawn from Quick-Lime did not ferment

ferment with Acids, yet this Salt upon ah affulion of Spirit of Salt would.

EXPERIMENT III.

An equal quantity of the powder of Human Blood and Oyl of Vitriol being mixed together. in a little time they grew warm; and then placing the Retort in a Sand Furnace, by degrees of fire we obtained a Spirit, which was preceded by a good deal of Phlegmatick Liquor of an odd Sulphureous fmell, and very strong and lasting. The Caput Mortuum seem-ed to be of a very compounded Nature. But one thing observable in our Experiment was, that the Oyl of Vitriol usually exercises a fixative Power, on many Bodies wherewith it is mixed in Distillation, yet this Experiment afforded us a pretty quantity of Volatile matter in the form of a white Salt, but of an uncommon fmell and tafte.

EXPERIMENT IV.

We prepared an Aurum Fulminans, precipitating a Solution of Gold made in Aqua Regia with Spirit of Human Blood, and by dulcifying the precipitate with common Water, and then drying it leifurely.

EXPERIMENT V.

Having immersed the Ball of a Weather-Glass in Spirit of Blood contained in a wide monthed Glass, we poured on some Spirit of VerdiVerdigreafe, which made a conflict with it and excited bubbles; there was likewise produced a degree of warmth not infensible on the outlide of the Glass; and the Liquor was raised in the Thermoscope a considerable height, tho' when the conflict was over it began moderately to fublide again.

EXPERIMENT VI.

Having gradually mixed Spririt of Blood, with as much Spirit of Nitre as it would work on it, they produced bubbles with a confiderable noise, and when the Liquors had fetled in a cool place, it appeared, that an Oyl had been separated from it in this operation; fince a red colour was not only produced by it, but the Surface of the Liquor was covered with such a film, as Liquors co-piously impregnated with Antimony or other fulphureous Bodies usually are. And when it was looked upon with Eyes conveniently placed in reference to it and the Light, it appeared to be adorned with vivid colours of a Rain-Bow, as Red, Yellow, Blue, and Green; and that too in their natural order.

EXPERIMENT VII.

Spirit of Human Blood which had been kept twelve years, being when it was looked upon not well stopped, it appeared to be a Spiritless Phlegm, but not of a red florid colour. and but little wasted.

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EXPERIMENE VIII.

Spirit of Human Blood being exposed to the Air in a frosty Night, in which Oyl of Vitriol was froze, it was not in the least altered or coagulated by it, but being put into a frigorifick Mixture, it was presently frozen.

EXPERIMENT IX.

A piece of black clotted Blood, being put into Spirit of Human Blood, it became of a florid colour, and retained that all Night.

EXPERIMENT X.

Spirit of Blood being poured upon powdered Blood, prefently diffolved part of it, and acquired a deep pleasant colour. But Spirit of Wine being poured upon another parcel, acquired not a Tincture, till urged with Heat; and then only a yellow one; but common Water presently dissolved a pretty deal of another parcel.

EXPERIMENT XI.

Spirit of Human Blood poured on lumps of Vitriol, disfolved them slowly without a froth; but upon the powder the folution was quicker and with a froth. And both the Solutions were of a more lovely blue than the Mineral it felf; nor was there a dark Precipitate

pitate as in a Mixture of ordinary Vitriol and Spirit of Urine.

EXPERIMENT XII.

Spirit of Human Blood employed for an invilible lnk, is much better than Serum of Blood.

EXPERIMENT XIII.

Having immersed the Ball of a Weather-Glass in distilled Water contained in a wide mouthed Glass, upon an affusion of two or three spoonfuls of Spirit of Human Blood, the tinged Spirit of Wine did presently subside in the Stem, within a little, as I have observed it with Spirit of Urine. And here it may not be amiss to take notice, that the reason why I employ distilled Water instead of common Water or Pump Water, is, because it is not impregnated with Salts, which may vary the success of the Experiment.

EXPERIMENT XIV.

Spirit of Blood being poured upon filings of Copper, and stopped up in a Glass extracted a Ceruleous Tincture, which in a few days gradually growing fainter, I opened the Glass upon which its Ceruleous colour was renewed, and extended it self downwards towards the bottom of the Vial, and so strong as to render the Liquor almost Opacous. And the Liquor

was stopped up several days after, yet it lost not its colour.

EXPERIMENT XV

Some of the same Spirit being poured upon Lapis Armenus, extracted from it a lovely and a deep blue, almost like a Solution of filings of crude Copper in the same Menstruum.

Poft fcript.

To conclude this Chapter I shall add, that tho' I have laid down these notes with what exactness was possible, yet I question not, but that the Blood of feveral, and even of the same Animals is so different at different times, that were they to be tryed over again they would scarce have the same effects; yet it. will not be a just reason to discourage others' in further Tryals, fince the advantage natural knowledge may attain by it, will be a fufficient reward.

CHAP. XI.

Of the Reconcileableness of Specifick Medicines, to the Corpuscular Phylosophy.

of feeifick D Efore I descend to shew that the notion D' of Specifick Medicines is agreeable to specifick Medicines, I shall first represent, that I am induced to believe that there are such, by

the common Observations of a great many learned Men and able Physicians; and to favour this common Observation, viz. That there are fuch Substances which have peculiar effects, which can be alcribed to no manifest Onalities. I shall urge the effects of Poysons taken in a very inconsiderable quantity. And I am told, that fomething that fell from a Spider into a Man's Eye caused him to lose his fight, to which I shall add, that Spiders are observed to kill flies, much fooner than cutting off their Heads, or running them through with Pins will do it. To which instances we may add, that most Poysons are cured by appropriated Antidotes; and as perfumes cause ill symtoms in many Histerick Women, so the fumes of Feathers burnt relieve them. And I have found that the smell of Spirit of Harts-horn or Sal-Armoniack, hath recovered People made fick by fragrant Odours. But beyond all other Arguments is experience; for Galen tells ts, That the ashes of a burnt Graw-Fish will ture the biting of a mad Dog, and that their effects are much more confiderable, if to ten Parts of burnt Craw-Fish we add five of Gentian and one of Frankincense. And Diascorides commends them against the same Disease that the Pergamenian does. And tho' the stings of Scorpions ufually produce very acute Pains and formidable Symtoms, yet the mischief is easily remedied, either by crushing the Body of the Scorpion upon the Hurt, or by anointing the Part with Oyl of Scorpions, the Liquor appears not to have any fensible Qualities, to which their Efficacy may be ascribed. M m *

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And to these Instances I might add, that Verginian Snake-weed cores the sting of a rattle Snake, and the Jesnit's Powder is a specifick in Agnes. And tho' it be argued against the Virtues of specifick Medicines, that they are altered by the ferment of the Stomach, and other strainers of different Textures, and that a great deal is carried off by Excrements, or is affimilated and converted into the Substance of our Bodies; yet to these things it may be answered, that not only Oyntments, Plaisten, Periapta, &c. work upon the mass of Humours: but even those Medicines which are allowed to work by manifest Qualities, perform what they do upon the account of their Particles alterering, and differently disposing the Hamours of our Bodies, and in doing of that they are liable to the same objections offered against specifick Medicines. Besides, it is observable that Rbubarb, will tinge the Urioe of those that take a considerable Dose. And there is a Fruit called prickled Pears in the English American Colonies, which passes by Urine, fo much unaltered, that the People think, when strangers to it, that they pis Blood. And Elaterium so much impregnates the Milk of a Nurse, that it will Purge the Child that takes it. And I remember that in the confines of Savoy and Swizerland, when the Cattle fed on a Herb called wild Garlick, the butter would sensibly taste of it. And in Ireland they have a kind of Sea-Fowl which feed upon Fishes, which is so little altered, as to make some question whether it be Flesh or Fish.

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And tho' it be further urged against Specilet Medicines, that so little is dispersed through the habit of the Body, that it can have considerable effects; yet their Efficacy may miwer for their imallness in quantity. For I am told that the Negroes have a Poylon, which tho' it work flow, is nevertheless Mortal, and this they conceal under the Nails of their Finers, and drop into the Aliment of those they have fpite to. And I know a Vegetable Subtance, half a Grain of which will be too violent a Purgative; and sometimes Mortal: And tho' English Vipers are looked upon as no Poylon, yet by the Wound of a fingle Tooth I knew one who was taken with violent Vomitings. To which may be added the terrible effects of Scorpions in the Island of Java. And we fee that feveral Women, otherwife frong and lufty, will fall into Swoons upon the smell of Musk or Civet, tho all the Effluvia that affect them, would not amount to the hundredth part of a Grain; and by Effluvia, perhaps not more plentiful these Symptoms may be again removed. And the Portions of Crocus Metallorum in Wine, or of Quick-Silver in Water, tho' small have very considerable effects, so that when a Child who obstinately refused all Medicines, drank small Beer impregnated with Mercury, he was much relieved in a violent worm Fever.

Having faid thus much of specifick Medi- Operations cines, I shall now proceed to lay down some chamically things in the following Propositions, to shew solved, is that they be mechanically explicated: But the follow-Arft I shall premise, that I would not have the ing Propose-

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That their Body time

Body to be considered as a dull lump of matter, but as an admirably contrived Mechanical Engin, consisting of Parts exquisitely contrived and adapted to their particular Uses; and that the effects of Bodies upon it may be considered in reference to that Disposition of their Parts.

This being premised there is no need to think, that all specificks act after the same manner, or the same way, and sometimes the specifick may operate by a joynt and in a compound way. But to proceed to the sol-

lowing Propositions.

Prop. 1.

PROP. L

Sometimes the specifick Medicine may care by discussing or resolving the Morbifick matter, and thereby making it sit for Expulsion by the greater common shores of the Body, and the Pores of the Skin,

Thus the Blood impregnated with Medicinal Particles, may act upon gross Humours which obstruct the Parts, and are not to be resolved without specifick Solvents, which by their figure and agitation may get in betwitt and separate those Viscous Parts; so Blood impregnated with Sal-Armoniack dissolves Copper, not by manifest Qualities; but by Virtue of the Shape, Bulk, Solidity, and other Mechanical affections of its Parts, which concur to enable it to disjoyn the Parts of a Body, of such a determinate Texture. And indeed there are not only a great number of

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Menstruums very different from one another, but their effects evidently appear not to depend mon manifest Qualities, fince it several times hoppens that a Menstruum less Acid, may difolve this or that Body, which a much fronger Menstruum will not work upon; fo Water will dissolve the white of an Egg, which Spirit of Wine will coagulate, and so will Spirit of Salt and Oyl of Tartar it felf; and this dephlegmed Spirit of Urine will more readily dissolve filings of Copper than Spirit d Vitriol, and yet the latter will speedily diffolve Crabs Eyes, tho' the other leaves them untouched; so Quick-Silver will dissolve Gold in the cold, tho' Aqua Fortis affifted by Heat leaves it untouched; yet Aqua Fortis will dissolve Iron, and Quick-silver will not. And Brimstone will be dissolved by common Oyl, tho' not by Aqua Fortis. And I mow a Liquor of which one may fafely drink Wine Glass full, tho' it will have such an effect upon Stones and Metals as can scarce be matched.

And if specifick Medicines may act upon Humours in the Body, after the manner of Menstruums, we may easily guess why they have peculiar Virtues, viz. By reason of their aptness to work upon peculiarly disposed Bodies, so, as I have elsewhere noted, Aqua Fortis will not work upon Silver if too strong,

till diluted with Water.

And as the diffolution of a Body may partly depend in its disposition, to be acted on by such a Menstruum, from thence may be M m 2 dedudeduced a reason, why a Medicine which hath good effects in one Disease may have but indifferent ones in others; for the pure Spirit of Wine will easily dissolve Gumm, Guajacum, and that Rolinous matter lodged in the Pores of the Wood, yet the same Menstruum will not work upon the Wood it felf. And if fo, no wonder that those Medicines which cure one Distemper in one Person, will not cure it in another, fince a Variation in the Texture of the Morbifick matter, is enough to vary the effects of the Medicines. And that a flight alteration of Texture varies the effects of a Menstruum appears; since, tho' Spirit of Nitre or Salt separate will each dissolve Copper; and the Spirit of Nitre will dissolve Silver, yet if Spirit of Salt be added to it, it foon lofes that Quality.

And here, tho' some object against specifick Medicines, that fince they rove up and down in the Blood, they cannot act well on particular Humours, yet if we suppose the Medicines act by impregnating the Blood, and that they turn it into a kind of Menstruum, it is possible that both the Menstruums may be appropriated to the peccant Humour, fo as to refolve it more easily than any other Humour of the Body. As if you take some Bone ashes, Crocus Martis, Saw-dust, Powdered Sea-Salt, and filings of Gold, and mix them together, common Water will disfolve the Salt and leave the others untouched, and Quick-Silver will alone disfolve the Gold: And those that work in Spanish Gold Mines tell

tel us, that Quick-Silver poured upon powdered Ore of Gold and Copper mixed, it will force meddle with the latter, till the former

is licked up.

And from what hath been said, we may be furnished with a reason of the effects of Priapta Amulets and Appensa, especially if we consider what hath already been delivered of the Effluviums of Bodies, and the Porosity of Animal Bodies; and tho' these Effluvium be very small in quantity, yet their effects may be more considerable, in as much as they are neither altered nor consumed, by previous digestions, and circulating through Parts, in which they might be in a great measure dispersed, and carried off a-long with the Exceptements.

PROP. II.

sometimes a specifick Medicine may mortifie the over Acid, or other immoderate Particles, that infest the mass of Blood, and destroy their Coagulatory or other Effests,

Tho' I believe not that all Distempers are, yet I question not but that a great many are caused either by Acids, or their ill effects or Productions; and which may be cured by specifick Medicines two ways, viz., either by mortifying them by a positive Hostility, such as Alkalizate Salts, whether fixt as the lixiviate Salts of Plants, or Volatile, as those of Urine, c.c. Or, by taking off or blunting

ing their edges; as a Knife may lose its power of cutting, by putting it in a sheath, or flicking fomething upon the edge; for the edges of an Acid may be taken off. as well by being lodged in a Porous Alkaly, as by having their edges broken off; and thus it is that Minium takes off the Acidity of Vinegar; Chalk takes off the edge of Aqua Fortis, and Lapis Calaminaris lessens the Acidity of Spirit of Salt and Spirit of Nitre; and that Acids are rather sheathed than altered by these Bodies, I am apt to believe, because as Glauber tells us, they may by a strong fire be drawn out of Lapis Calaminaris much stronger and more dephlegmed than be-

And tho' it may be urged by those that plead against specifick Medicines, that they act by a manifest Quality, viz. their Alkalions Nature, or their Acid; yet there is fo great a variety betwixt Acid and Alkalious Medicines themselves, that I am perswaded they perform a great deal upon the account of something else, besides their Acid or Alkalious Nature, fince Aqua Fortis will not dissolve Gold tho it will Silver, but if it be altered by an addition of Spirit of Salt, it will diffolye Gold and not Silver. And a derent Modification may not only make a difference betwirt Acids, but a contrariety; fince Spirit of Salt will precipitate Silver, which Agna Fortis hath diffolved: And Spirit of Nitre will precipitate out of Butter of Antimony, an Antimonial powder with a confiderable

iderable Conflict and Effervescence; yet this Patter of Antimony is fo highly Acid, that a little quantity of it put into a little Water makes it fo fower, that many Chymists call it Actum Philosophorum. And as there are several kinds of Acids and of Alkalies too, so every Alkaly will not mortifie the fame Acid; for tho' Chalk will precipitate a Solution of Copper in Aqua Fortis, yet a Volatile Alkaly will not. And indeed when I consider what difference there naturally is betwixt Acids, it is not unreasonable to expect, that there may be Acid Humours produced in the Body utterly unknown to us, and which may require a specifick Alkaly to correct them, as it is observed, that tho' neither Spirit of Vinegar, nor Spirit of Salt, nor Oyl of Vitriol, will dislolve a Calculus Humanus, yet Spirit of Nitre will, and by that means lofes its Corroliveness.

And to what hath been faid, I shall add, that I am of opinion that particular Acids may be the occasion of Distempers, which they are by some rather taken to be Remedies; for tho' Acids are looked upon to be of an incisive Nature, and tho' in some cases I am willing to allow them those Virtues; yet I believe that Obstructions and the Diseases depending therein, are caused by Acids coagulating, some sluids disposed to be thickned by them; which might be exemplished by the Coagulation I have made of some Acid Salts, as Spirit of Salt, of the white of an Egg, which by being beaten is reduced to an Aqueous consistence:

stence: And Milk will be coagulated not only by Spirit of Salt, but Rennet and Juice of Limons, and it hath been found by experience. that some Acids transmitted into the mass of Blood, have coagulated it in living Animals.

But tho' I believe a great many Distempers are occasioned by Acids, yet I conceive some are occasioned by Acid Salts uniting with other Saline Bodies; as Spirit of Salt, and Spirit of Urine produce a Sal-Armoniack. And Spirit of Nitre with Salt of Tartar diffolved in common Water will coagulate with it into Salt-Petre; and the same Spirit of Nitre with Spirit of Urine will produce a very fulible Salt, different from either of the Ingredients; and Oyl of Vitriol or Oyl of Tartar per Deliquium will produce Tartarum Vitriolatum; in which both the Acidity and Alkaliousness of the Ingredients are much infringed, the Body resulting from the compofition being different from both the Ingredidients: And if belides these instances we confider how many different Substances may be produced by Nature, I am apt to believe, that specifick Qualities are requisite to alter or destroy them, in the Medicines made use of for that purpose.

And to what hath been faid, I shall further add, that I have mixed two Liquors together neither of which were Acid or Atkalious, and yet the resulting Body was a consistent Coagulum. And I have prepared a certain Liquor, which upon the affusion of Spirit of U-

rine

rine will be turned into a Gelly. And the like I have produced without the help of either an Acid or an Alkaly. And I have had a Substance prepared without the help of a Volatile Alkaly, which would in a trice coagulate highly rectified Spirit of Wine; and as Spirit of Salt will coagulate the white of an Leg, so will dephlegmed Spirit of Wine; so that an Animal Substance may be coagulated without an Acid.

PROP. III.

Sometimes a Specifick Medicine may bely the Prop. III.

Patient, by Precipitating the peccant matter
out of bis Blood, or the other Liquors of the
Body in which it barbours.

Tho' Precipitation be generally a Confequent of the Mortification of Acids or Alkalies, by Corpuscles of a contrary Quality, yet some Acids and Alkalies may be mixed without a precipitation of any thing; and feveral Precipitations may be caused without any such manifest Hostility. As in certain mixtures of Spirit of Sal-Armoniac made with Salt of Tartar or Potalhes, and Spirit of Nitre, or Aqua Fortis; and also when Spirit of Urine and Salt, are mixed in a certain proportion, make Sal Armoniac, which the Phlegm of those Liquors will keep swimming; and that there may be Precipitations without any appearance of contrariety, is evident, when Silver being diffolved in Aqua-Fortis, the Menstruum is diluted with Thirty

or Forty Parts of Distill'd Water; for if clean Plates of Copper be immerfed in the Solution. the Metal will be flowly precipitated out of it, in the form, not of a Calx, but pure shining Scales of Silver; and if you rub Dantzick Vitriol upon the Blade of a Knife well wetted with Water, the Steel in a trice will be overlaid with a reddish substance, which by its Colour and Signs appears manifestly cupreous. And here I shall add, that there are in Nature, Precipitants which filently precipitate some Bodies dissolved in Urinous Menstruums.

And the' against the Use of Precipitating Medicines, it may be urged, that the Heterogenous Particles precipitated, may be of dangerous consequence, yet they may be less pernicious than those hostile Particles that produce the Disease. And further, they may not be so big, but that it is possible for them to be carried out of the mais of Blood, fince those Mineral Substances dissolved in Tunbridge Waters, and the Sulphureous ones in the Bath, chiefly perform their effects by being disperfed through, and acting on the feveral Parts of the Body.

But moreover it is possible Precipitations may be made in the mais of Blood, without the Medicine getting into it, which is observed in the use of Chalybeat Medicines; where were it arged, that they pass through the Pores of the Guts, then there is no reason why there are not Pores in the Body large enough to carry off the Precipitated Parts of the mass of

Blood.

And

And not only Sennertus makes use of Medicines in Fevers, to Precipitate the febrile matter, but Kergerus very solemnly declares that he cured thousands only by a Precipita-

ting Medicine.

And that Precipitating may be of use in Physick, I am the more inclined to believe, if a Putrefaction of Humours be rightly assigned as the cause of some Distempers; because I know a Liquor which being dropped into stinking Water, Precipitated a light Feculency out of it, upon which the Liquor was wholly freed from its stink, nor could I perceive that the Feculency it self had any; and what was more remarkable was, that the taste of this Precipitant was neither Bitter, Acid, Urinous or Lixiviate.

PROP. IV.

Sometimes the Specifick Remedy may work by peculiarly strengthening and cheristing the Heart; the part affected, or both.

That a Medicine may have peculiar effects on this or that Part, I am inclined to believe for the following reasons. First, because the several Parts of the Body are of differently framed, and have different Humours lodged in them; and consequently the Parts of a Medicine dispersed through the Body, may be more aptly appropriated to be received or detained in those Parts; and the Parts being thus strengthened may be more able

to refift the influence of Morbifick Humours, by which means they are thrown upon more ignoble Parts, for which reason, some Persons are seised with the Gout; and I know a Gentleman, who tho he could drink Wine without much burt, yet Brandy would cause

him to have a fevere Tooth-ach.

But to illustrate what I was saying, of the disposition of some Parts of Medicines to associate themselves with those Parts they seem friendly to; I shall add, that in non-rishing Children, Milk does not only afford grosser Faces, and various other Excrements as Urine, Mucous, and a Humour by insensible Transpiration, but Particles which upon their being assimilated increase the bulk of the Body; and whereas it is observed, that some Cartilages in Children acquire a Bony hardness in older Persons, this change cannot be supposed to be the bare effect of Exsiccation.

And as Specifick Medicines may confirm the ftrength of a Part, so they may conduce to the restoreing of strength to the weak Part, by removing Distempered Humours; and this they may do, not only by altering the whole mass of Blood, but their peculiar disposition to act on the Distempered Humour And as the Morbifick matter is diversify'd, according the disposition of the part it is lodged in, so must the Medicine be Specifically appropriated. And as they contribute to the removal of a Distempered Humour, so consequently they will to the strengthening

of the fibres of those Parts; either by giving them a firmness; or by correcting their immoderate Heat or Cold; or correcting the Humours lodged in the Pores of the Part, or by takeing away the Convulsive or inordinate motions of the Parts; or by relaxing, or otherwise altering their Pores, or causing the matter lodged there to be expelled by a gentle or violent agitation; as when Cambarides cause an Excretion of Urine, or Gravel, by irritating the fibres of the Bladder: And the effects of this Medicine alone are sufficient to prove, that there may be Specifick Medicines which chiefly respect particular Parts; since Cambarides pass through the Body, without affecting any other part but the Bladder.

And tho' at the first a Medicine may chiefly respect a particular part, without altering the Blood, yet when once it hath caused a change in it, the Blood it felf, as it successively circulates through that Part, may in some measure act Specifically upon it. And tho' a Medicine may communicate to the Blood Particles of matter so modified, that they may not immediately relieve the Part, by either ftrengthening it, or causing the Distempered matter to be carried off by a gentle irritation, yet it may do it by both these ways, as when Rhubarb is taken, it not only purges the Liver of Choler, but ftrengthens the Tone of the Parts by its aftringency. And Ofteocalla is observed to be a Specifick, by promoteing the Generation of a Callus, to cement broken Bones.

Medicines

PROP.

no chall state on PROP. V.

Prop. V.

Sometimes a Specifick Medicine may all, by producing in the mass of Blood such a disposition, as may enable Nature, by correcting, expelling, or other fit ways, to furmount the Morbifick matter, or other cause of the Difeafe.

And this is agreeable enough with what most Moderns hold, viz. That Distempers chiefly depend upon the Temper and ill Constitution of the Humours. And a change in

the Humours may be effected.

By furnishing the Blood with some fort of active Corpufcles, which may agitate and ferment it, and to quicken the Circulation of the Blood. Upon which occasion it may be necessary to advertise, That the Medicines usually made use of for that purpose being very hot; there are several Constitutions of Patients, and feveral other Circucumstances, upon which account they do more harm by their Heat, than good by their Spirituousness; besides the fluggishness and want of fermentation in the Blood, may proceed from canses which this fort of Medicine will not correct; for I have tryed, that a Vinous Spirit would not dissolve Blood which was a little dryed, nor draw a Tincture from it, tho' an Urinous Spitit presently did; so that a Specifick Medicine in such a case may perform what is intended, without the inconveniences which other Medicines

Medicines are liable to: For we know that experienced Physicians, call some Medicines cold Cordials, as Sorrel, which hath an Acid taste; and it is possible sometimes those Humours which make the Blood sluggish may not be of a cold, but a hot Nature, in which cases hot Remedies may rather increase than diminish their ill effects; as if the white of an Egg be reduced to Water by beating, Spirit of Wine will instead of diminishing increase its Viscidity. And I once prepared a Vegetable Substance, which upon an addition of Wine became much more Viscous than before.

But to proceed, a Specifick Medicine may alter the mass of Blood, by contributing to its Tenacity, without respect to its Fermentation; for if the Blood be too thick, it cannot readily pass through the small Capillary Vessels, by which Circulation is in a great means retarded; as on the other Hand, if it be too thin, it gets out of the Capillary Vessels, and first Stagnates, and then Putrifies; but these ill consequences may be prevented, by such Medicines as either on the one Hand divide the Parts of the Blood, and make them more minute, or on the other such as associate them, and stick them together.

Another way by which a Specifick Medicine may rectifie the state of the Blood, is, by working so upon the Heart, as to make it transmit Blood more advantageously; and that either by corroborating its sibres, or dissolving some ill distempered matter, that

Nn*

obstructs

obstructs the Contraction of it; and that a small alteration in the Constitution of the Heart, may do much in respect of the Circulation of the Blood, will be easily granted by any one, that does but confider what infensible Agents actuate it. And that the almost insensible Obstruction of Circulation produces confiderable effects in the Body is evident, from the effects of Sorrow, which presently puts the whole Body out of order; and also from the effects of Joy or shame, both of which promote the Circulation of the Blood; and it hath been observed, that loy hath had so sudden and considerable an effect, as to take off the sharpness of Hunger; and that Medicines may affect the Heart after the same manner, I am inclined to believe; especially since I knew a Lady, who was so affected upon the smell of perfumed Gloves, that the Blood flew into her Face, and put fuch a colour into it as if the had bluthed. And if the state of the Blood may be thus altered, it may much contribute to the removal of fome very troublesome Distemper, induced for want of a due Circulation of the Blood.

PROP. VI.

mediant a Specifick Remedy may unite with the percent matter, and compose a Quid Natrum, which may be less offensive to Name, the not so easily expelled.

And this feems to me to be the most the effects of a Specifick Medicine; and peccant Acids are lodged in the peccant Actus art less sapid, Alkamay unite with them, without creating manifest disturbance; and form a harm-Liquor; as Aqua Fortis, by being digestand distilled with a very ardent Spirit, its corrolive Acidity and ill fcent, and mes a harmless, sweet, and fragrant Liand I knew one who relieved a Netick Patient, with the use of inflamable prite. And I have elfewhere shown, that mly, but variously, according to the Natire and proportion of the Acid. And Spint of Wine mixed with rectified Spirit of Urine, will in a great measure take off the corroding Qualities of it, and composes a alt which is weaker than the Spirit, and being subtimed or reduced to a Liquor, becomes good Medicine; and with a little skill will mic a very good Menstruum in several Chy-Experiments. That sed or row soften a sesund the effects of I fluorist

A

A few Grains of Glass of Antimony taken inwardly, will both Vomit and Purge, but if instead of Spirit of Wine we make use of that of Vinegar, and when by digestion the Liquor is fufficiently impregnated, it be abstracted, Antimonial and Acetons Corpuscles emerge, feveral Grains of which may be taken without either Vomiting or Purging; from whence it appears, that all Correctors are not to be effeemed Alkalies, fince Acids themselves prove to be Correctors too. And after a like manner not improbably, the Poylons of Animals and others may be subdued.

And it is not improbable, that by a Combination of a Diffempered Humour with a Medicine a Salutiferous Liquor may be formed, and the fometimes a Medicine is altered before it comes to the part affected, yet that alteration may render it Medicinal: An instance of the former we have in the Preparation of Mercurius Dulcis, where by uniting Poyfon with Quick-Silver, an Efficacious Medicines is made; and an Illustration of the latter may be brought from that Odour which it gives to the Urine of the Person who takes it, different from any smell it had of it self before.

And tho' against what hath been been faid, for Specifick Medicines some may offer that there are some which are only externally applyed; yet from what hath been faid, of the Porofity of Bodies and the effects of Effluvia, it will easily appear how they may influence the

the Body, and alter the Humours which cirmate in it; and to what is there offered we may reasonably add, the ill effects of Amulie of Arsenick mentioned by Diemerbreek, and the effects of Cambarides upon some Person who only wore them in their Pockta.

And indeed there are a great many Medidies externally Specificks, which one would not take to be fo, as Camphire, which interselly is very hot and good in fome Maligmot fevers, yet outwardly it is used to take . of Heat Pimples in the Face, and in cooling Oyntments, and against Burns; and Spirit of Wine, tho very hot when internally used, yet it, if presently applyed, takes out the fire Burns. And to mild a Body as Bread, if chewed and outwardly applyed, hath confidemble Virtues in external affections. have several times eaten a thing without any fich effect, which a Physician told me extersally applyed would Purge Children, being neither offenfive in colour, imell or Gripe-

And to these instances I shall add, That Galen tells us, that an Epileptick Boy was free from such Fits, as long as he wore only Piony Root as an Appensum. And I knew one who was Paralitick, that was suddenly relieved in violent Cramps, only by handling the Tooth of a River-Horse; and I as well as others have been relieved in the Cramp, by putting a sking made of an Elks Hoos upon my singer. And I knew another cured of an In-

continentia

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continentia

continentia Urina by the fole use of an Appension. And a Lady had a Scrophulous Tumor difpelled, only by fucceffively applying the Body of a dead Man to the part affected, till the cold fensibly penetrated into it. And I my felf and not only a violent Hamorrhage speedily stopped, by holding moss of a dead Man's Skull in my hand; but a Gentleman told me, that if when he was let Blood he held it in his hand, no Blood would flow out till he laid it aside. And another told me, that he had been freed from a Palpitation of his Heart. which usually fell upon him after a few hours fleep with great terror, only by wearing smooth and flat Cornelians in a bag over the pit of his Stomach.

Galen tells us, That Jaspers worn after the fame manner are good for the Stomach; and Monardes tells us, that the Bleeding of the Hemorrhoids have been stopped, by wearing a Ring made of a Blood-Stone upon the fingers. And not only Boetius and Johannes de Last commends Lapis Nephriticus, but the experienced Monardes and others, And Untrems tells us, that by wearing this Stone some Parts of the Stone were made fo minute as to be expelled out at the Eyes: And that one that had a Catarrh was Purged fourteen times in one day by wearing of it; and it had the like effect, tho' not so strongly upon another.

Bit.

To conclude this Discourse, I shall here advertise the Reader, that tho? I have laid down feveral.

feveral ways by which Specifick Medicines might operate, yet I think not those always fingly effectual, but that sometimes they joyntly contribute to the producing of the effect; without enlarging upon this account I shall only subjoyn, that I hope from what hath been already delivered it may appear, that the Doctrine of Specifick Medicines is not irreconcileable to the Principles of the Corpuscular Philosophy.

CHAP. XII.

A short account of Ambergrease communicated in the Transactions of October 6. 1673.

I Received the following account from one of the Committee of the East-India Company. "Ambergrease is not the Scum or Excrement of the Whale, &c. but issues out of the Root of a Tree, which always fhoots out its Roots towards the Sea, feeking the warmth of it, thereby to deliver the fattest Gum that comes out of it. Which Tree otherwise by its copicular to the Sea, it is wery tough, and can scarce be loosened.

ed from the Root, except by its own Weight or the Motion of the Sea.

"If you Plant the Trees, where the tream fets to the shore, it will cast it up to great advantage. March 1. 1672. in Batavia Journal, Advice From, &c.

FINIS.

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